The Drivers of Nature-based Tourism Across Africa and Great Britain.

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Abstract

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The Drivers of Nature-based Tourism Across Africa and Great Britain

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Nature-based tourism (NBT) develops when tourists visit sites (generally protected areas; PAs) to experience natural features or participate in nature-related activities such as wildlife-watching. NBT can generate revenue for conservation, local communities, and national economic development, contributing to the protection of nature's strongholds. Despite this, the drivers of NBT are poorly understood. Using the number of tourism resources in which a species was mentioned as an indicator of their popularity for NBT, traits associated with the popularity of species were identified in this study and their use in predicting visitor numbers to African National Parks (NPs) and British PAs was explored. Infrared camera traps were also piloted as visitor recorders across 27 British sites, and provided visitor count data on a cost-effective basis, especially for PAs with lower visitor numbers. The popularity of African birds was driven by range size and body mass, whereas the popularity of British birds was driven by trophic level and plumage patterning. The popularity of both African and British mammals was driven by range size and sociality, but body mass was the strongest driver in African mammals. Visitor numbers to African NPs and British PAs were driven by habitat diversity, accessibility, and wildlife popularity, but the level of human development also influenced tourism across African countries. Species currently overlooked, and sites currently underutilised by tourists relative to their traits were identified and could benefit from marketing. Promotion, product, price, and place marketing techniques can be used to control visitor flow, generating an equilibrium between visitor pressure and expectations, economic revenue, and sustainable conservation management. Additional factors, such as aesthetic landscape appeal, which could influence species and site popularity were identified and could be investigated in future study. Consultation of additional tourism resources and access to additional visitor number records, potentially through the use of infrared camera traps, could also enhance our understanding of which species and site features drive NBT.

DURHAM UNIVERSITY

MASTERS THESIS

The Drivers of Nature-based Tourism Across Africa and Great Britain

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"It seems to me that the natural world is the greatest source of excitement; the greatest source of visual beauty, the greatest source of intellectual interest. It is the greatest source of so much life that it makes life worth living."

Sir David Attenborough

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List of Abbreviations

AIC	**A**kaike **I**nformation **C**riterion
AONB	**A**rea of **O**utstanding **N**atural **B**eauty
BCC	**B**irds of **C**onservation **C**oncern
BCI	**B**right **C**olour **I**ndex
BTO	**B**ritish **T**rust for **O**rnithology
CE	**C**hoice **E**xperimentation
CEG	**C**onservation **E**cology **G**roup
CV	**C**ontingent **V**aluation
FE	**F**orestry **E**ngland
GB	**G**reat **B**ritain
GDP	**G**ross **D**omestic **P**roduct
GLM	**G**eneralized **L**inear **M**odel
GLMM	**G**eneralized **L**inear **M**ixed-effects **M**odel
HBW	**H**andbook of the **B**irds of the **W**orld
HMW	**H**andbook of the **M**ammals of the **W**orld
IUCN	**I**nternational **U**nion for **C**onservation of **N**ature
LSC	**L**eisure **S**pecialisation **C**ontinuum
NB	**N**ature **B**ased
NBT	**N**ature **B**ased **T**ourism
NE	**N**atural **E**ngland
NP	**N**ational **P**ark
NRW	**N**atural **R**esources **W**ales
NT	**N**ational **T**rust
PA	**P**rotected **A**rea
RA	**R**ecreational **A**rea
RSPB	**R**oyal **S**ociety for the **P**rotection of **B**irds
SDXC	**S**ecure **D**igital e**X**tended **C**apacity
SNH	**S**cottish **N**atural **H**eritage
TCM	**T**ravel **C**ost **M**ethod
TEV	**T**otal **E**conomic **V**alue
WB	**W**ildlife **B**ased
WBT	**W**ildlife **B**ased **T**ourism
WDPA	**W**orld **D**atabase on **P**rotected **A**reas
WT	The **W**ildlife **T**rusts

Declaration of Authorship

I, Holly Megan APPLEBY, declare that this thesis titled, “The Drivers of Nature-based Tourism Across Africa and Great Britain” and the work presented in it are my own. I confirm that:

- This work was done wholly or mainly while in candidature for a research degree at this University.
- Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated.
- Where I have consulted the published work of others, this is always clearly attributed.
- Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work.
- I have acknowledged all main sources of help.
- Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself.

Signed: H M Appleby

Date: 17/04/2021

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Chapter 1

Introduction

1.1 Current Threats to Global Biodiversity

Maintaining biodiversity is crucial to sustain functioning ecosystems and, therefore, human society (Costanza et al., 1997; Gössling, 1999; Xu and Fox, 2014). Consequently, there is a growing awareness of the importance of nature conservation with regards to its Total Economic Value (TEV; Tisdell and Wilson, 2003; Turner et al., 2003). The TEV refers to the *direct* and *indirect* uses associated with ecosystem services, such as production of food and leisure activities, as well as less tractable *non-use* values associated with option, existence and bequest values (Costanza et al., 1997; Tisdell and Wilson, 2003). Despite its value, the threats to safeguarding biodiversity are omnipresent. Global biodiversity is currently in decline due to widespread environmental and anthropogenic stressors, such as habitat degradation, over-exploitation by humans, and climate change (Abukari and Mwalyosi, 2018; Battersby, 2005; Howard, Flather, and Stephens, 2020; Kissui, 2008; Morris, 2003; Myers, 1972; Parmesan and Yohe, 2003; Thomas et al., 2004; White et al., 1997).

Protected areas (PAs) are designated based upon the primary aim of conserving biodiversity and reducing threats (King et al., 2012; Reed and Merenlender, 2008). The current PA extent only covers 15.4% of the Earth's terrestrial surface (Juffe-Bignoli et al., 2014). Many are insufficiently managed, merely existing as "paper parks" (Wilkie, Carpenter, and Zhang, 2001). Global conservation efforts, not limited to PAs, remain underfunded, and vital resources are allocated based on a "triage" basis, rendering conservation biology a crisis discipline (Bottrill et al., 2008; Wilkie and Carpenter, 1999a). The failure to calculate, recognise, and appreciate the TEV of biodiversity and ecosystem services manifests in the inadequate investment into conservation globally.

Noticing and quantifying the costs of conserving the world's biodiversity is much more straightforward than noticing and quantifying the benefits of nature preservation. Local communities within developing countries disproportionately bear these direct costs of PA management as well as the opportunity costs of conservation (Wilkie and Carpenter, 1999a). For example, PAs can "parasitize" on local communities, restricting their livelihoods and utilisation of natural resources, claiming their land rights, and forcing them to relocate outside of park boundaries (Ferreira, 2004; Mamo, 2015). PAs harbour wildlife which can overspill into local communities and lead to zoonotic outbreaks, crop raiding and livestock predation. These are major causes of economic loss and food insecurity (Abukari and Mwalyosi, 2018; Mackenzie and Ahabyona, 2012; Newsome, Dowling, and Moore, 2005; Weladji and Tchamba, 2003). Consequently, negative attitudes towards wildlife conservation and management develop within local communities, encouraging people to, for example, ignore PA management regulations that aim to protect wildlife (Nyhus et al., 2005) and engage in activities which may be unsustainable or illegal, such as poaching and retaliatory killing of wildlife (Abukari and Mwalyosi, 2018; Kissui, 2008; Woodroffe, Thirgood, and Rabinowitz, 2005) and logging (Abukari and Mwalyosi, 2018; Weladji and Tchamba, 2003).

The benefits of conserving biodiversity seldom outweigh the competitive monetary incentives for land development and high costs of PA and wildlife management, therefore often impeding the designation of PAs, particularly in developing countries which are unable or unwilling to pay for PA management (Jackson and Gaston, 2008; Wilkie, Carpenter, and Zhang, 2001; Wilkie and Carpenter, 1999b). If species are to persist, and ecosystems are to function sustainably in support of human society, then sources of economic value of nature must be recognised, both within and outside the current PA network and used to offset any costs incurred (Gössling, 1999; Wilkie and Carpenter, 1999a).

1.2 Is Nature-based Tourism the Answer?

1.2.1 An Introduction to Nature-based Tourism

Travel and tourism is the fastest growing industry in the world (Gössling, 2000; Lindsey et al., 2007), and generates 10.3 % of global GDP (World Travel & Tourism Council, 2019). Twenty per cent of global international travel and tourism can be accounted for by nature-based tourism (NBT), which develops when tourists travel to a site to experience natural features or participate in nature-related activities (Balmford et al., 2009; Balmford et al., 2015; Beedie and Hudson, 2003; Whitlock, Romer, and Becker, 1991; Fig. 1.1). NBT in turn generates wealth for conservation management, PA designation, local community development and even national economic development and therefore is widely regarded as a contributor to the protection of nature's strongholds (Eagles, 2014; Gössling, 1999; Higginbottom, Tribe, and Booth, 2003; Krüger, 2005; Page and Connell, 2009; Shiel, Rayment, and Burton, 2002; Wilkie and Carpenter, 1999a).

Wildlife-based tourism (WBT), a sector of NBT which has an annual turnover of US$30 billion (Lindberg, 1991), is associated more closely with tourists who desire wildlife interactions and encounters (see Orams, 1996a). The definition of WBT is debated, with some excluding consumptive tourism (Duffus and Dearden, 1990; Morrison, 1995), and others including consumptive tourism (Reynolds and Braithwaite, 2001). This study adopts the former, whereby WBT excludes consumptive and low-consumptive uses of wildlife, including interactions within captive and semi-captive situations. PAs can provide the

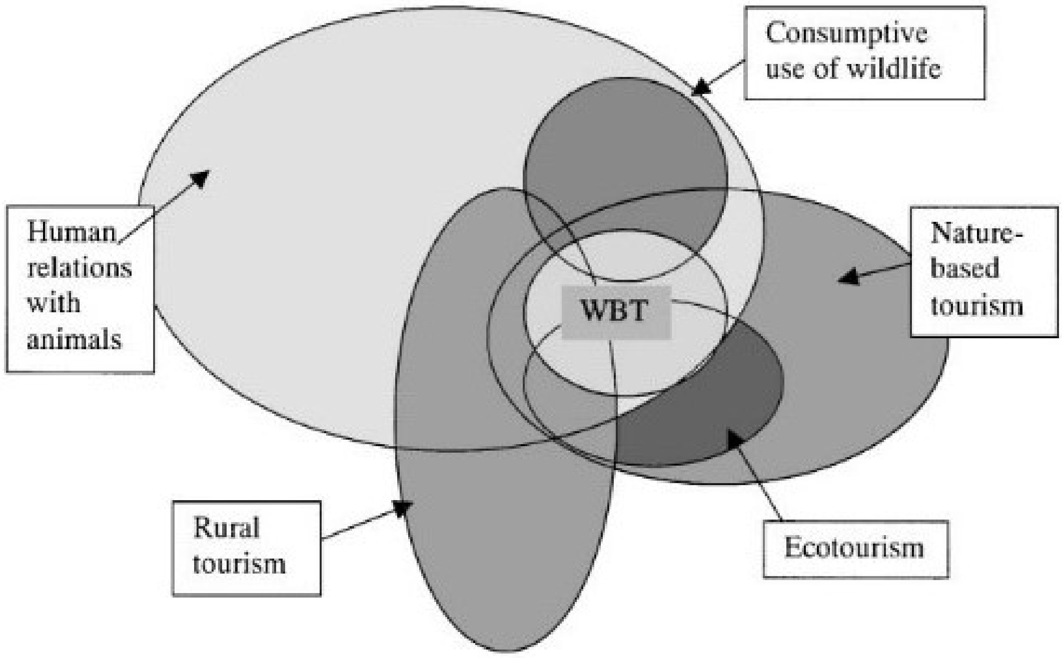

FIGURE 1.1: The multiple forms of NBT (Reynolds and Braithwaite, 2001).

most opportune human-wildlife interactions within natural environments (Walpole and Goodwin, 2001). These memorable experiences can further be enhanced by centring PAs on, for example, breeding sites or migratory routes, or by providing regulated access to these sites (e.g. Butynski and Kalina, 1998).

Based on records from 1998-2007, it is suggested that the global PA network attracts 8 billion visitors annually (Balmford et al., 2015). At the time of writing, global travel and tourism has been suspended due to the Covid-19 outbreak, with considerable consequences for the PAs and communities that depend on the industry. Prior to Covid-19, there is evidence of growth in the annual visitor numbers to natural areas outside of Japan and the USA (Balmford et al., 2009). The decline in NBT in Japan and the USA is thought to be related to increased wealth and associated drive for international travel and tourism within these nations (Balmford et al., 2009). Declines may also be partially driven by the rise of urbanisation, videophilia and sedentary lifestyles (Pergams and Zaradic, 2006), which may contribute to degradation of mental and physical wellbeing (Pyle, 2003). In contrast, increased urbanisation has also been linked to an increased demand for natural experiences and dislocation from society (Beedie and Hudson, 2003; Reynolds and Braithwaite, 2001). If the public's interest shifts away from conserving biodiversity and towards focusing on economic gain then future generations may not be environmentally conscious enough to invest in protecting natural environments (Balmford and Cowling, 2006; Kareiva, 2008; Pyle, 1993; Pyle, 2003). Similarly, some "ecocentric" individuals which recognise the environmental costs of NBT, such as environmental degradation, may refrain from tourism activities to reduce their contribution to these costs (Xu and Fox, 2014).

However, there is a general consensus that non-captive human-wildlife interactions and experiences within PAs are becoming more popular (Clamen and Rossier, 1991; Duffus and Dearden, 1990; Duffus and Wipond, 1992; Heath, 1992; Muir and Chester, 1993; Orams, 1996a). This is reflected in the number of restrictions placed on visitors to minimise negative impacts, such as licensing and physical controls on tourist movement (Armstrong and Kern, 2011; Butynski and Kalina, 1998; Orams, 1996a; Orams, 1996b). Visits to PAs in developing countries are increasing by roughly 4 % annually (Balmford et al., 2009), with a 10 % annual growth in general NBT participation (Tapper, 2006). This reflects the broader interest of the public in NBT and the environment, possibly due to the greater public valuation and understanding of the need to contribute to conservation through NBT in recent years (Gauthier, 1993; Reynolds and Braithwaite, 2001). Despite this view, increased motivation is difficult to analyse quantitatively due to the scale of global travel and tourism (Curtin, 2013a). The growing interest in NBT and PAs can be partially attributed to the factors outlined in Table 1.1.

A symbiotic relationship exists between conservation biology and NBT, raising the importance of NBT as an ecosystem service (Balmford et al., 2009; Balmford et al., 2015; Buckley, 2004; Budowski, 1976; Gössling, 1999; Millenium Ecosystem Assessment, 2005; Naidoo et al., 2011). Not only does NBT generate financial flows between different sectors outlined by figure 1.1, rendering PAs as significant players within rural business management (Rotherham, 2007), but it also assists in building positive relationships between local communities and conservationists. Considering over 80% of global PA visits occur in Europe and North America (Balmford et al., 2015), a shift from NBT could have drastic effects on the global economics of travel and tourism, not to mention region-specific expenditure on conservation initiatives. To manage the growing interest in tourism and the associated PA usage sustainably and responsibly, it is important to understand the costs and benefits of tourism, the motivations behind NBT, the needs of all stakeholders, and how demand for NBT might change in the future (Blackstock et al., 2008; Eagles, 2014; Eagles, Mccool, and Haynes, 2002; MacLellan, 1999; Myers, 1972).

TABLE 1.1: Primary factors which contribute to the growth in NBT and PA visitation

Factors that contribute to the growth in NBT and PA visitation	**Sources**
A growing interest in conservation ecology and green awareness, as well as increased societal concern over animal welfare and ecosystem resilience (reflected by "ecocentric" viewpoints)	Reynolds and Braithwaite (2001)
A shift in human behaviour towards a more active, sightseeing lifestyle, associated with awareness of the mental and physical health benefits of nature	Amante-Helweg (1996); Barton and Pretty (2010)
Instinctive behaviour of humans to connect with nature (e.g. Biophilia)	Wilson (1984)
The growing universal presence of opportunities to participate in NBT (e.g. tourist resorts and tour guide operators)	Curtin (2013b); Jenner and Smith (1992); Lemelin et al. (2010); Orams (1996a)
Increased ability to reach more remote destinations due to advances in transport and associated infrastructure	Butler (1985); Shackley (1996)
The development of open-access CCTV footage of fragile unapproachable wildlife	Dickie, Hughes, and Esteban (2006)
An increase in wildlife and nature represented in television and the media (e.g. The "Attenborough Effect")	Beeton (2006); Bulbeck (2005); Colléony et al. (2017); Curtin (2005); Curtin (2013a); MacLellan (1999)
The pursuit of existential authenticity and "sense of place" experiences away from the increasingly urbanised world	Akama and Kieti (2003); Beedie and Hudson (2003); Curtin (2005); Fredrickson and Anderson (1999); Grünewald, Schleuning, and Böhning-Gaese (2016); Hausmann et al. (2017b); Lemelin (2006)
The search for new, untouched destinations due to the stagnation and overcrowding of over-utilised sites (e.g. "Trailblazing")	Burns and Holden (1995); Shackley (1996)
The growth of "last chance tourism", where visitors seek opportunities to view endangered species and threatened landscapes which are most at risk from climate change, land use change and human encroachment	Frost, Laing, and Beeton (2014); Groulx et al. (2016); Lemelin et al. (2010); Orams (2002)

1.2.2 The Benefits of Nature-based Tourism

The collective global terrestrial PA network is thought to generate an annual direct in-country expenditure of US$600 billion (excluding indirect and induced expenditure) (Balmford et al., 2015). The business case for ecological conservation has led to an increase in studies focusing on the implications of NBT with relation to PA management (Carlsen and Wood, 2004; Hughes and Carlsen, 2009).

Many PAs are in remote and rural areas where unemployment and economic difficulties are rife; locals rely on income from traditional practices such as fishing and agriculture due to the lack of interest from secondary, tertiary and quaternary industries (MacLellan, 1999). The development of PAs, particularly within these locations, can facilitate financial flows between conservation organisations and local communities, enhancing the sustainability prospect of tourism (Spenceley, 2008). PAs require management, protection, monitoring and other services, such as tour-guiding (Curtin, 2010). Thus, they provide employment and volunteer opportunities for local people. The employees and volunteers of PAs spend money on goods and services, further providing indirect employment, for example with forestry and construction contractors (Shiel, Rayment, and Burton, 2002). Many PAs also let out land for agriculture and game hunting, creating further employment and generating money from the sale of food and timber (Shiel, Rayment, and Burton, 2002). For example, the annual selling and processing of venison in Scotland generates £10 million (Prentice, 2006).

Indeed, employment opportunities associated with travel, tourism and conservation management are widespread. The related income can drastically improve the quality of life within local communities, especially in developing countries, for example by allowing families to pay school fees and construct houses (Sebele, 2010; Walpole and Goodwin, 2001; Walpole and Thouless, 2005). Demands for such employment develop within the hospitality and airline industries as well as through tourist expenditure on local crafts and goods (Dzingirai, 2004). Funds raised through NBT can also contribute towards local community development projects such as improved road networks and school infrastructure (Mbaiwa, 2003; Mbaiwa and Stronza, 2010; Mehta and Pawliczek, 2012).

The expenditure of nature-based (NB) tourists in and around destinations has been widely studied, especially within Great Britain (GB). For example, the tourism sector in Orkney had a turnover of £18 million in 2000, mainly attributable to the wildlife, landscape, history and archaeology of the area (Dickie, Hughes, and Esteban, 2006). More specifically, an annual tourist expenditure of £1 million can be attributed to bird life on the Shetland Isles, accounting for 25% of total visitor spending (Rayment, 1997; TMS, 1996). Many projects conducted by the Royal Society for the Protection of Birds (RSPB) have looked at the effect of the presence of individual species on visitor spending in local areas around reserves in GB. For example, sea eagle tourism, *Haliaeetus albicilla*, on the Isle of Mull generates an annual £1.5 million, choughs, *Pyrrhocorax pyrrhocorax*, around the Lizard in Cornwall attract an annual £118,000, and red kites, *Milvus milvus*, attract an annual

£116,000 to the Black Isle (Dickie, Hughes, and Esteban, 2006; Rayment, 1997). Ospreys *Pandion haliaetus*, are additional highly valued British tourism attractors, with visitor spending of £3.5 million attributed to the presence of individuals at only nine public watching sites (Dickie, Hughes, and Esteban, 2006). Such estimates of visitor spending attributable to wildlife may have also increased since the time of publication due to the growth of tourism over recent years.

Clearly, visitor spending can be attributable to the presence of particular wildlife. In turn, tourists play a critical role in funding wildlife preservation and justifying the expansion of the PA network by contributing to management costs, especially where government funding is scarce (Jackson and Gaston, 2008; Okello, Manka, and D'Amour, 2008; Wilkie and Carpenter, 1999b). Many tourists also engage with direct conservation efforts, such as species translocations, habitat protection and breeding programmes, particularly when utilising ecotourism operators (Buckley, 2009; Cousins, 2007). Indeed, WBT can enhance advocation for species conservation; for example, the value of an individual macaw derived from wildlife-viewing can reach US$1650,000, thus far outweighing consumptive macaw hunting in the Amazon (Munn, 1992). The direct and indirect monetary value of red deer, *Cervus elaphus*, to the Scottish economy through wildlife related tourism, hunting and venison production accumulates to £370 million, offsetting the deer costs associated with road traffic accidents (RTAs), fence management, and crop damage (Macmillan and Phillip, 2008; Putman and Moore, 1998). Similarly, revenue from WBT in Africa can be used to compensate for the costs associated with crop-raiding or livestock predation (BigLife Foundation, 2020; Walpole and Leader-Williams, 2002). Likewise, fishing quotas, marine protected areas (MPA) and Special Areas of Conservation (SAC) have been designated following the realisation of the economic benefits of, for example, shark watching (Topelko and Dearden, 2005) and dolphin-tourism (Hughes, 2001).

The growth of the tourism industry not only generates revenue, but also generates positive relations and interactions between local communities, tourists, and conservation organisations (Van der Duim and Caalders, 2002). The realisation of the social and economic benefits of tourism by local communities enhances their appreciation for conservation and PA management and reduces their involvement in illegal or controversial activities (BigLife Foundation, 2020). NBT also allows visitors to participate in unique and memorable experiences whilst exploring biodiverse landscapes (Curtin, 2013a). People are educated by these experiences, thus, their exposure to nature strengthens their understanding of sustainable tourism and conservation biology, promoting "ecocentric" behaviours (Balmford et al., 2009; Morrison, 1995; Xu and Fox, 2014).

1.2.3 The Costs of Nature-based Tourism

Nature is often perceived to have poor investment returns (Catlin et al., 2013). The revenue from NBT seldom outweighs PA management costs and is rarely redirected back into management, biodiversity conservation or community projects (Bookbinder et al., 1998; Eagles, 2002; Lindsey et al., 2007; Sandbrook, 2010; Walpole and Thouless, 2005;

Wells, 1993; Wilkie and Carpenter, 1999a). Thus, vital resources are often redirected from government-managed conservation initiatives to sectors of perceived greater societal importance, such as health and education (Alpízar, 2006; Athanas et al., 2001; Eagles, 2003; Font, Cochrane, and Tapper, 2004; Krug, Suich, and Haimbodi, 2002). As previously mentioned, the development of PAs and tourism ventures can negatively affect local communities through commodification, forceful relocation, claiming of land rights, and restriction of natural resource use, which undoubtedly harm their indigenous identities and traditions (Ferreira, 2004; Stelios and Melisidou, 2010; Mamo, 2015; Myers, 1972). Likewise, global travel and tourism can exploit and damage the environment in a "parasitic" manner. Increased CO_2 emissions and air pollution, for example, contribute to one of the greatest threats against biodiversity persistence: climate change (Bookbinder et al., 1998; Buckley, 2009; Butynski and Kalina, 1998; Kiss, 2004; Reed and Merenlender, 2008; Stanford, 2014; Walpole and Goodwin, 2000; Walpole and Thouless, 2005). More specifically, many PAs which are reliant upon NBT revenue (Dharmaratne, Yee Sang, and Walling, 2000; Eagles, 2014; Margules and Pressey, 2000) preferentially manage their sites to satisfy presumed tourist demands at the expense of conservation (Novellie, 1991; Maciejewski and Kerley, 2014b; Maciejewski and Kerley, 2014a), which can also compromise the NBT experience and result in tourist dissatisfaction (Markwell, 2001; Prakash et al., 2019; Xu and Fox, 2014). For example, high-impact activities and infrastructure may be developed within many PAs due to "Trojan Horse" effects, i.e. with the aim of accommodating increased visitor numbers and enhancing the presumed appeal of the site to tourists (also referred to as "recreational succession"; Buckley, 2009; Pleumarom, 1993; Wheeller, 1997).

Such issues associated with inappropriate or exploitational PA management and NBT based upon presumed tourism attractiveness are outlined here, first listed by Knight and Cole, 1995, and more recently by Reynolds and Braithwaite, 2001. First, habitats can be severely modified and disturbed by tourist operations and PA management strategies: (1) introduction of invasive species or overstocking of species can promote diseases which can alter floral and faunal compositions, facilitating further colonisation (Chin et al., 2000); (2) habitats can be cleared for infrastructure development; (3) the availability of resources can be reduced from increased concentrations of more "desired" flora and fauna, including extralimital species and charismatic megafauna (e.g. Maciejewski and Kerley, 2014b; Maciejewski and Kerley, 2014a); (4) footpaths and unrestricted trekking can lead to erosion and substrate compaction; (5) tree thinning, felling and mowing can alter plant community structure and (6) vehicles and waste, including dog foul, can emit pollutants and chemicals and host diseases.

Direct impacts on species can further exacerbate ecosystem alterations: (1) consumptive NBT such as hunting and fishing typically results in mortality; (2) collisions of wildlife with vehicles can result in mortality or injury; (3) disturbance or habitat modification can lead to decolonisation or mortality; (4) increased vigilance and reduced feeding time can alter species' energetic regimes and result in deteriorating physical condition (Stronza and Pêgas, 2008); (5) species can habituate to human presence, potentially increasing their risk of mortality with relation to consumptive tourism; (6) feeding stations can alter dietary composition; (7) artificial resources, such as water points, can increase encounter rates and therefore aberrant social behaviours and potential population crashes (e.g. Harrington et al., 2014); (8) tourists can interfere with breeding situations by disturbing pairs, resulting in nest absconsion, reduced hatchling success and/or increased predation (Burger and Gochfeld, 1993; Mathieson and Wall, 1982) and (9) game hunting can alter animal activity patterns and energy budgets, further disrupting predator-prey relationships (Chin et al., 2000).

All of these direct impacts are exacerbated with pressure from increased tourist visitation, many of whom will not be environmentally conscious (Duffus and Dearden, 1990). Clearly, in order to reduce the negative impacts of NBT and PA management whilst promoting the associated benefits described above, the underpinning factors which drive tourism visitation must be understood.

1.3 Understanding the Drivers of Nature-based Tourism

Despite the recognised dependence of sustainable tourism management on the understanding of the drivers of NBT (Eagles, Mccool, and Haynes, 2002), the influencers on tourist decision-making with regards to choosing a specific destination remain poorly understood (Reynolds and Braithwaite, 2001; Naidoo and Adamowicz, 2005; Catlin and Jones, 2010). According to Ajzen's Theory of Planned Behaviour (1988), an individual's decisions are influenced by: (1) personal attitudes towards performing that behaviour (e.g. the personal benefits of visiting a PA); (2) subjective norms (e.g. the individual's belief that others would approve or disapprove of the individual visiting a PA) and (3) perceived behavioural control (e.g. the influence of previous experiences on, or anticipated barriers to, visiting a PA) (Ajzen, 1988; Stanford, 2014).

By identifying the underpinning needs and motivations of tourists, methods of broadening the benefits of NBT, controlling visitor flow and limiting negative impacts of tourism can be identified (Eagles, Mccool, and Haynes, 2002). As a consequence, such PA management techniques can generate an equilibrium between visitor pressure and expectations, economic revenue, and sustainable conservation management, whilst providing indicators of levels of environmental damage and recovery (Armstrong and Kern, 2011; Beeton and Benfield, 2002; Wearing and Nelson, 2004).

Ascertaining which species are of appeal to tourists can influence the WBT tourism potential of PAs by conserving and promoting such attractive species, modifying tourism satisfaction (Akama and Kieti, 2003; Bentz et al., 2016a; Okello, Manka, and D'Amour, 2008) and potentially driving tourists towards areas which are currently underutilised. Likewise, species which are identified as receiving most visitor engagement may be preferentially protected and monitored to minimise the negative impacts associated with NBT. Furthermore, the identification of "Cinderella species" (Smith et al., 2012), those which are currently overlooked by tourists, can be marketed to promote awareness for the conservation of wider biodiversity (Goodwin and Leader-Williams, 2000; Smith et al., 2012), including through flagship campaigns. Changes in species management and promotional material can open up overlooked natural resources to generate funds for local community development and conservation management, subsequently diverting tourism pressure away from sites which are currently exploited by the tourism industry and over-utilised by visitors (Armstrong and Kern, 2011; Beeton and Benfield, 2002). Studies could also highlight the extent to which the current natural and captive networks distort management priorities towards conserving physically appealing species rather than those most threatened by extinction (Frynta et al., 2010b). Future changes in tourism potential could also be identified by mapping species distributions under future economic and climate change scenarios, potentially identifying locations of future wildlife tourism hot-spots which would benefit from ongoing protection.

Discovering which site features are of value to tourists can also influence the NBT potential of PAs by managing and promoting such features, modifying tourism satisfaction (Akama and Kieti, 2003). Marketing material can be used to encourage tourism visitation to under-utilised sites, which in turn could facilitate local economic development, and divert tourism from heavily exploited sites which have surpassed the social carrying capacities of the areas (Armstrong and Kern, 2011; Bayliss et al., 2014; Beeton and Benfield, 2002; Dharmaratne, Yee Sang, and Walling, 2000; Ferreira and Harmse, 1999; Ferreira and Harmse, 2014; Lindsey et al., 2007). Similarly, identifying levels of visitor usage is critical to implement management within PAs (Hadwen, Hill, and Pickering, 2007; Reynolds and Elson, 1996), for example, the provision of maintenance and resources as well as the scheduling of staff allocation (Cessford and Muhar, 2003). Moreover, modelling tourism visitation to sites based on values of site features could assist in identifying destinations which are most dependent on tourism visitation for economic gain and therefore will be most drastically affected by global challenges, such as the current Covid-19 pandemic.

Several authors have explored the attributes of species and sites that are of most value to tourists as a consequence of their perceived importance. It is relatively easy to estimate the value of consumptive NBT uses, such as sport hunting and fishing due to the presence of commercial markets (Macmillan and Phillip, 2008). Non-use values associated with wildlife watching, photography and hiking however, do not necessarily require the payment of a fee or depend on commercial facilities, therefore cannot so easily be captured by the market (Macmillan and Phillip, 2008).

Studies eliciting non-use values and tourist "preferences" therefore typically apply stated or revealed preference techniques, such as contingent valuation (CV) or choice experimentation (CE). The former generally involves surveys questioning participants how much they are willing to pay to protect or manage a particular attribute (Garrod and Willis, 1994; Saayman and Saayman, 2017; White et al., 1997; White, Bennett, and Hayes, 2001), or how much respondents have paid to travel to the attribute or destination e.g.

travel cost method (TCM; Clawson, 1972). The latter involves surveys asking respondents to choose attributes with designated prices from a range of hypothetical alternatives.

Such techniques have been widely adopted to provide insight on wildlife and destination features which appeal most to the public (Di Minin et al., 2013; Moran, 1994; Naidoo and Adamowicz, 2005) as outlined below. These techniques, however, have been widely criticised (e.g. TCM; Tisdell and Wilson, 2003, Moyle and Evans, 2008), especially by those who believe that non-market attributes should not be assigned an economic value. Stated preference techniques are further subject to yea-saying (Blamey, Gordon, and Chapman, 1999), sensitive to the magnitude of the good or service that is being offered (Lew, 2015), contain unrepresentative samples with little information (Farr, Stoeckl, and Alam Beg, 2014; Lew, 2015; Ressurreição et al., 2011; Ressurreição et al., 2012), and predominantly have little spatial and temporal coverage as they are costly and time consuming (Hill and Courtney, 2006; Richards and Friess, 2015; Wood et al., 2013).

More recent techniques have taken advantage of the increasing use of worldwide social media platforms such as Facebook, Instagram, Twitter and Flickr (Hausmann et al., 2018), by correlating attributes with social media hits (Hausmann et al., 2017b; Willemen et al., 2015). Social media facilitates the use of large sample sizes with great spatial coverage and without introducing non-response biases (Mayer-Schönberger and Cukier, 2013). Social media techniques however, are limited by the unrepresentativeness of the NBT population, with relation to photographic ability (Mancini, Coghill, and Lusseau, 2016) and can be subject to location inaccuracy (Tufekci, 2014).

Therefore, novel approaches which are cost-effective and with large spatial and temporal scales could be considered to derive what features most appeal to tourists. Such an approach for identifying attractive species and their appealing characteristics could involve the use of WBT resources, such as guidebooks and reports, which are suggested to promote species which are of interest to tourists in order to pull visitors to particular destinations. Images of endemic species, for example, have been used as "selling points" for NBT destinations (Curtin and Wilkes, 2005). An additional, alternative approach to determining site features which attract tourists is to correlate features with actual visitor numbers (e.g. Balmford et al., 2015). Visitation data is widely available and the results of such studies could directly influence NBT and PA management decision-making processes.

1.3.1 Species Attributes

Several studies have identified species attributes which influence the appeal of species to the public. The most appealing taxa suggested by the literature are mammals and birds (Czech, Krausman, and Borkhataria, 1998; Goodwin and Leader-Williams, 2000; Kerley, Geach, and Vial, 2003; Lišková and Frynta, 2013; Seddon, Soorae, and Launay, 2005). In particular, a dependence of tourism operators and conservation campaigns on charismatic megafauna has been highlighted (Goodwin and Leader-Williams, 2000; Kerley, Geach, and Vial, 2003; Lindsey et al., 2007). There is no defining feature of "charisma" however (Lorimer, 2006), it is only suggested that charismatic species evoke strong emotions (Lorimer, 2007), are large (Clucas, McHugh, and Caro, 2008; Lorimer, 2007), approachable, and playful (Tremblay, 2002).

Marketing and media fuel the narrow preferences for charismatic species. For example, many flagship campaigns, which aim to raise funds for conservation initiatives, utilise species which are aesthetically charismatic (Barua, 2011; Smith et al., 2012). This typically attracts the attention of the general public who are usually uneducated about species conservation and persistence (Barua, 2011; Smith, Macmillan, and Veríssimo, 2010; Smith et al., 2012). Such marketing has been criticized due to the direction of raised funds towards few specific species which are not necessarily the most in need (Joseph et al., 2011; Smith et al., 2012). In Africa, such predominant flagship species for conservation and tourism include the "Big Five"; the African savannah elephant, *Loxodonta africana*, African Buffalo, *Syncerus caffer*, leopard, *Panthera pardus*, lion, *Panthera leo*, and the black rhinoceros, *Diceros bicornis* (Lindsey et al., 2007). The "Big Five" were originally selected for being the toughest animals to hunt (Mellon, 1975; Williams, Burgess, and Rahbek, 2000), yet are now seen as the backbone of tourism within Africa, despite their expensive management costs (e.g. anti-poaching) and potential threat to local communities (e.g. crop raiding) (Lindsey et al., 2007; Mackenzie and Ahabyona, 2012). As a consequence, the costs associated with conserving charismatic tourism attractor species may outweigh the benefits from non-consumptive tourism, and similarly restrict the funding available for less charismatic species (Kerley, Geach, and Vial, 2003; Maciejewski and Kerley, 2014b).

This suggests that management and marketing of species can influence their appeal towards NB tourists, in turn governing tourist preferences. Indeed, many PA management priorities have been focused on the few selected charismatic species, resulting in an underappreciation of wider biodiversity and less charismatic wildlife (Goodwin and Leader-Williams, 2000; Lorimer, 2006; Priskin, 2001; Reynolds and Braithwaite, 2001), which are often of greater conservation concern (Smith et al., 2012; Willemen et al., 2015). This further creates perturbations for destinations which would benefit from the presence of tourism operators but do not harbour species labelled as "charismatic" (Krüger, 2005; Lindsey et al., 2007). The acknowledgement of the implications for conserving charismatic megafauna at the detriment of less charismatic species has fuelled the demand to shed light on tourist preferences for wider biodiversity and to elucidate the defining characteristics of "charisma". Similarly, the over-exposure of flagship species can lead to "flagship fatigue" potentially shifting public interest to new, under-appreciated species (Bowen-Jones and Entwistle, 2002) and "Cinderella" species (Smith et al., 2012).

Table 1.2 outlines the attributes of species which are thought to influence their appeal to the public. Large bodied, aesthetically appealing, approachable and rare species tend to be most popular among the public, as indicated by the literature.

TABLE 1.2: Perceived attractive species attributes according to examples of previous studies

Source	Appealing species attributes cited in the literature
Clucas, McHugh, and Caro (2008)	Large-bodied, carnivorous, endangered mammals and large bodied, omnivorous or piscivorous birds of little conservation concern
Curtin and Wilkes (2005)	Presence of anthropomorphic features
Di Minin et al. (2013)	Large-bodied, rare, difficult to observe, group-living
Frynta et al. (2010a)	Large-bodied, long tails, bright colouration (blue, orange and yellow)
Frynta et al. (2013)	Large-bodied mammals, aesthetically appealing, high perceived cognitive capacity
Grünewald, Schleuning, and Böhning-Gaese (2016)	Large-bodied, predatory, associated with open vegetation
Hausmann et al. (2017a)	Small-bodied mammals and birds
Hausmann et al. (2018)	Large-bodied mammals
Kerley, Geach, and Vial (2003)	Large-bodied mammals, easily approachable, species associated with open habitats
Lindsey et al. (2007)	Large-bodied, charismatic mammals, predatory
Lišková and Frynta (2013)	Large-bodied, bright colouration (blue and yellow), light colouration
Lorenz (1971)	Neotenic features (e.g. relatively large head, flat face, large eyes)
Lorimer (2006)	Aesthetically appealing, large eyes, “cuddly” appearance
Macdonald et al. (2015)	No baldness, single bright colours, forward facing eyes, prominent facial markings, threat to humans, critically endangered IUCN extinction risk
Maciejewski and Kerley (2014b)	Large-bodied mammals, indigenous, relatively rare
Martin (1997)	Large-bodied mammals, birds of prey, rare, endangered
Okello, Manka, and D’Amour (2008)	Large-bodied mammals, predatory, abundant, relatively rare, interesting behaviours (e.g. fighting, mating, grooming), cultural depictions (e.g. lions), fabled reputation (e.g. spotted hyena)
Reynolds and Braithwaite (2001)	Predictable, approachable, associated with open vegetation, tolerant of human intrusion, relatively rare, super-abundant, diurnal
Smith et al. (2012)	Large-bodied mammals, carnivorous, forward-facing eyes
Stokes (2007)	Warm colouration (red and yellow), non-neotenic features
Veríssimo et al., 2009	Endemic, rare, unique, presence of unusual characteristics, physically appealing
Veríssimo et al. (2017)	Physically appealing, threatened
Willemen et al. (2015)	Large-bodied, herbivorous and carnivorous mammals
Woods (2000)	Related to human society (e.g. domestic, companion animals), high perceived cognitive capacity, affectionate, playful, large-bodied, unthreatening, physically appealing (colourful, “beautiful”, “fluffy”, “cute”), easy to anthropomorphise (“affectionate”), tolerant of humans

1.3.2 Site Attributes

The public generally value site traits associated with natural and socio-economic factors, some of which have previously been identified in Table 1.3. Many tourists, in particular wildlife-based (WB) tourists visit PAs to participate in wildlife-watching experiences, typically aiming to view specific species which are of value to them. Charismatic megafauna and large carnivores, for example, are the main attraction for tourists visiting African PAs (Maciejewski and Kerley, 2014b; Maciejewski and Kerley, 2014a; Okello, Manka, and D'Amour, 2008; Grünewald, Schleuning, and Böhning-Gaese, 2016; Lindsey et al., 2007), and dolphins attract WB tourists to the Moray Firth in Scotland (Hughes, 2001). Previous studies regarding preferences for charismatic species suggest that sites lacking such key species have reduced tourism potential and therefore receive reduced funding and innovation.

Despite this, many tourists are attracted to sites which possess less charismatic species, biodiversity related activities, natural landscapes and geological features, potentially due to the associated wilderness and "sense of place" experiences (Curtin and Wilkes, 2005; Grünewald, Schleuning, and Böhning-Gaese, 2016; Hausmann et al., 2017b). Many tourists, for example, venture to mountainous regions, such as the Himalayas, to participate in thrill-seeking activities away from their increasingly urbanised lives (Beedie and Hudson, 2003). Nonetheless, many sites possess extraordinary natural features, yet tourist visitation may be limited due to socio-economic factors associated with political instability, remoteness and the absence of visitor facilities (Akama and Kieti, 2003; Martin, 1997; Wilkie and Carpenter, 1999a). Many of these sites which cannot attract mass tourism may alter their marketing strategies to attract visitors which prefer to take part in consumptive tourism or "adventure tourism" as means of generating revenue (Balmford and Whitten, 2003; Novelli, Barnes, and Humavindu, 2006; Wilkie and Carpenter, 1999b; Zurick, 1992).

TABLE 1.3: Perceived attractive site attributes according to examples of previous studies

Source	**Appealing site attributes cited in the literature**
Akama and Kieti (2003)	Presences of natural attractions, presence of facilities, uncrowded, informative staff, accessible, good transport network, located within politically stable countries
Beedie and Hudson (2003)	Sense of adventure, authentic experiences
Curtin (2005)	Sense of place experiences and existential authenticity
Curtin (2010)	Presence of tour guides
Curtin (2013a)	Experienced tourists prefer basic infrastructure and remoteness, generalist tourists prefer high levels of infrastructure, guidance and "signposting"
Grünewald, Schleuning, and Böhning-Gaese (2016)	High biodiversity, presence of large predators, river and get-off points, diverse vegetation, open vegetation, variety of landscapes
Hausmann et al. (2017a)	Sense of place experiences, diverse landscapes, less charismatic biodiversity, biodiversity-related activities (camping, guided game drives), uncrowded, high vegetation diversity
Hausmann et al. (2017b)	Accessible, sparse vegetation, high human population density, located within countries of high GDP, low richness in non-charismatic species
Hausmann et al. (2018)	Diverse landscapes
Kerley, Geach, and Vial (2003)	Presence of charismatic species, diverse scenery, accessible, open habitats
Lindsey et al. (2007)	High mammal diversity, presence of large predators, diverse scenery
Maciejewski and Kerley (2014b)	High biodiversity, availability of the "Big Five"
Martin (1997)	Opportunities to view wildlife, high species richness, presence of interpretive resources, visitor centre and recreational facilities, guided tours, uncrowded
Naidoo and Adamowicz (2005)	Bird richness, opportunities to view large wildlife, cheap entrance fees, presence of luxury accommodation, high vegetation diversity
Naidoo et al. (2011)	High species richness, presence of key species, low rainfall, remote
Neuvonen et al. (2010)	Well-established (old), accessible, high vegetation diversity, provision of trails, many opportunities to participate in recreational activities
Okello, Manka, and D'Amour (2008)	Presence of tour guides
Reynolds and Braithwaite (2001)	High species richness, open habitats with some coverage, presence of features which concentrate animal activity, safe transport on site
Richardson and Loomis (2004)	Warm temperatures, presence of conifer forests and wildflowers
Wilkie and Carpenter (1999a)	Located within politically stable countries, low travel cost, highly accessible

1.4 The Wildlife Tourism Framework

The Wildlife Tourism Framework (WTF; Duffus and Dearden, 1990) is regarded as the most relevant concept which could be used as a blueprint to define PA management actions (Catlin, Jones, and Jones, 2011). The WTF comprises the Leisure Specialisation Continuum (LSC; Bryan, 1977), Butler's Tourism Life-Cycle (Fig. 1.2; Butler, 1980), and Limits of Acceptable Change (LAC; Stankey et al., 1985), to represent the dynamics of WBT, and in turn it can be applied to NBT in general.

NB tourists are viewed to sit along a Leisure Specialisation Continuum (Bryan, 1977). At one end, the generalist (or novice) visitor is thought to be poorly educated, not environmentally conscious, and to require facilities such as shops, cafes, and viewing hides which engender habitat modification and wildlife disturbance (Duffus and Dearden, 1990). For generalist and first time tourists, charismatic species are thought to be of greatest appeal (Di Minin et al., 2013; Goodwin and Leader-Williams, 2000; Kerley, Geach, and Vial, 2003). At the other extremity, the specialist (or expert) visitor is thought to be more educated about conservation and wildlife-viewing practices, demands less infrastructure and services, and is less tolerant to crowding, thus tend to visit more remote, less commercially developed sites and have less detrimental impact on wildlife. For *specialists*, the presence of greater biodiversity, including rare and endangered species, are important drivers (Lindsey et al., 2007). The concept of a tourism continuum illustrates the array of attractive attributes outlined in the previous two tables.

The position of an individual along this continuum is clearly dependent on factors such as knowledge and awareness of environmental issues, as well as income, age, and occupation (e.g. Di Minin et al., 2013). Similarly, domestic tourists are thought to be interested in landscapes and scenery, placing lower economic value on wildlife than international tourists (Lindsey et al., 2007; Ressurreição et al., 2012). Moreover, motivations may be influenced by nationality (Packer, Ballantyne, and Hughes, 2014), for example, North American tourists are suspected to be most interested in rare and unique species (Moscardo and Saltzer, 2004). Over time, tourists are expected to shift along the continuum towards the specialist extremity by gaining more knowledge, skills, and equipment, in turn becoming more committed to the NB experiences (Bryan, 1977). Tourists may develop 'place identity' and 'place attachment' (Gieseking et al., 2014) through nature experiences, for example, influencing their perceptions of tourism destinations and human-environmental relations (Fredrickson and Anderson, 1999).

This framework suggests that sites also change over time, typically mirroring the focus of management towards economic gain by attracting mass generalist tourists. As a site progresses through different life-cycle stages, visitors from different places along the LSC are attracted to the site, progressively being swamped by more generalist tourists who tolerate crowding (Duffus and Dearden, 1990). Sites develop through increased advertisement, commercialisation, and infrastructure development with the goal of increasing visitor usage, and therefore revenue. Continued development to an unacceptable level however, predominantly forces visitor numbers to decline due to tension with local people, overcrowding, negative impacts associated with 'recreational succession' and violations of ecological carrying capacity, defined by the Limits of Acceptable Change (Avila-Foucat et al., 2013; Bentz et al., 2016b; Bentz et al., 2016a; Buckley, 2009; Duffus and Dearden, 1990; Hausmann et al., 2017b; Lindsey et al., 2007; Ziegler, Dearden, and Rollins, 2012). Such influx of generalist tourists places great pressure on biodiversity, therefore requiring greater management intervention (Catlin, Jones, and Jones, 2011), and the optional advancement of non-wildlife associated attractions such as 'adventure tourism'.

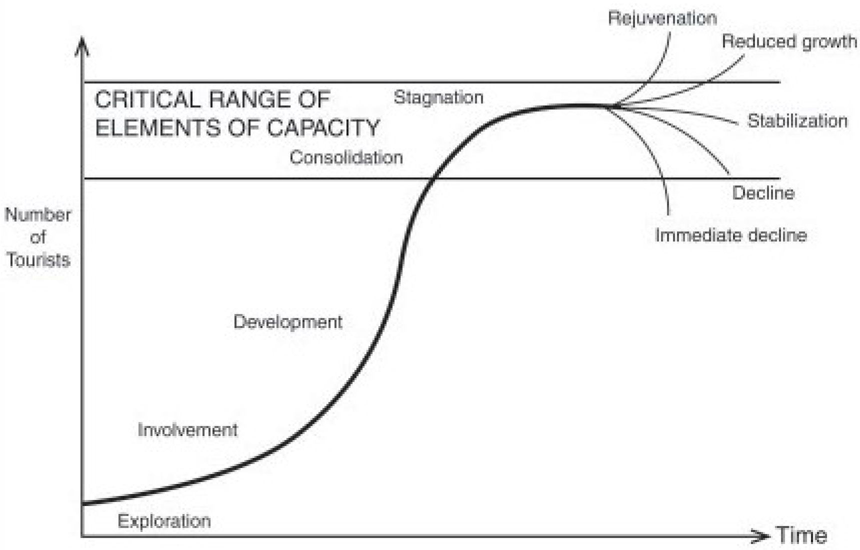

FIGURE 1.2: The tourism area life-cycle model (Butler, 1980)

The WTF shows that PA managers would do best to conserve the vast array of opportunities and encounters that nature has to offer, and clearly, tourists are a valued method of generating interest and revenue to do so. The framework underlines the importance of understanding what makes species and sites attractive to tourists so that PA managers can use the information for marketing purposes to attract different types of visitors. It is clear that sustainable PA management must evolve alongside these tourism drivers to prevent any limits of acceptable change from being violated, and therefore preventing a parasitic relationship from developing between humans and nature (Markwell, 2001; Xu and Fox, 2014), whilst taking the future effects of, for example, global pandemics and climate change into consideration.

1.5 Conclusion

It is apparent that the field of NBT is relatively well researched from a theoretical viewpoint. The potential benefits of NBT and WBT are becoming increasingly recognised, however the issues associated with environmental degradation due to the overdevelopment of visitor facilities as a result of presumed visitor preferences and demand have led to the view that the current NBT industry is far from sustainable (Buckley, 2009; Eagles, Mccool, and Haynes, 2002; Huang et al., 2008; La Page, 2010). NBT is less well understood from an empirical view of what drives such tourism. It is this latter query that is the main focus of this research thesis, which aims to understand the species and site features which drive NBT, by building on the literature that documents the benefits, and costs of NBT, and hence how resources might be better exploited currently, or how resource use might change under future scenarios. This thesis also aims to pilot the use of infrared camera traps as visitor monitors, which could provide valuable means of collecting visitor data which could subsequently be used to identify the drivers of NBT.

The thesis plan, below, outlines the main questions which will be addressed in this thesis, and the ways in which the questions will be tackled.

1.6 Thesis Plan

This thesis will attempt to quantify the principle drivers of NBT and identify a means of monitoring NBT by addressing the following questions:

1. What are the traits of species that attract tourism?
2. What are the features of protected areas that attract tourism?
3. Can modified infrared wildlife cameras be used to monitor tourism visitation?

This thesis adopts an alternative method to contingent valuation and choice experimentation to identify the traits which make species attractive to tourists, utilising WBT resources, such as guidebooks and brochures. The idea that such resources provide valuable proxy for the popularity of species for WBT is explored (rather than allocating species with monetary values) with the assumption that species of great popularity, or appeal to tourists, are be mentioned more frequently across the resources. Information will be collated on species traits to build a modelling framework to explore which traits best explain species popularity within the tourism resources. The hypothesis that certain traits (e.g. large body size, colouration) make some species more popular than others will be tested. Consequently, the species that have great tourism potential, but are currently not utilised as tourism attractors by the wildlife-tourism resources will be identified.

This thesis follows the approach of Balmford et al. (2015) to identify PA traits which appeal to tourists by utilising visitor number data. Information will be collated on PA traits to build a modelling framework to explore which traits best predict visitor numbers to PAs. The hypothesis that certain site features (e.g. area of PA, wildlife popularity) will make some PAs more attractive to tourists than others will be tested. Consequently, examples of PAs which are currently over- and under-exploited by the tourism industry, relative to these features, will be identified.

Chapter 2 will address questions one and two, by exploring the drivers of NBT across African national parks (NPs). African NPs are the epitome of the NBT experience due to the presence of charismatic megafauna, expansive landscapes, and well-established tourism operators (Goodwin and Leader-Williams, 2000; Lindsey et al., 2007; Okello, Manka, and D'Amour, 2008). Indeed, many developing countries and communities in Africa, as well as the NPs themselves, depend on tourism revenue (Eagles, 2014; Goodwin and Leader-Williams, 2000; Okello, Manka, and D'Amour, 2008; Walpole and Thouless, 2005; Willemen et al., 2015; Wilkie and Carpenter, 1999a). The drivers of NBT within Africa have been widely studied (e.g. Di Minin et al., 2013; Lindsey et al., 2007; Okello, Manka, and D'Amour, 2008). Such studies however, typically focus on charismatic megafauna, including the renowned "Big Five", and thus, species management and marketing implications tend to disregard wider biodiversity (Goodwin and Leader-Williams, 2000). By considering a wider range of species, those currently over-looked by the tourism literature could provide new opportunities for tourism development. Likewise, exploring the drivers of tourism visitation across Africa could assist in identifying regions of high tourism potential and therefore sources of revenue for local communities and biodiversity management.

Chapter 3 will also address questions one and two by exploring the drivers of NBT across Great British PAs. Few studies have solely considered the tourism potential of the British species assemblage despite the large resource base of both species' trait data and wildlife-tourism resources. Over recent years, domestic tourism has been on the rise due to economic recessions, increased accessibility to remote locations and a growing awareness of the negative impacts of international travel (Butler, 1985; Hughes, 2001; VisitBritain, 2018). Moreover, domestic tourism is expected to continue to rise in the future as a result of the Covid-19 pandemic. Therefore, it is of growing importance to predict the flow of tourism across GB so marketing and management implications can be put in place to facilitate sustainable NBT experiences.

Chapter 4 will pilot the use of modified infrared wildlife cameras as visitor counters within British PAs and recreational areas. Methodologies typically utilised to record PA visitor numbers have involved verbal reports from visitors and guesswork (Arnberger and Hinterberger, 2003). Recently, social media has rendered itself as a proxy for visitation rate (Donahue et al., 2018; Hausmann et al., 2017b; Mancini, Coghill, and Lusseau, 2016; Sonter et al., 2016; Wood et al., 2013), yet such data are subject to the limitations associated with photographic ability and location inaccuracy (Mancini, Coghill, and Lusseau, 2016; Tufekci, 2014). Therefore, it is important to consider novel approaches for monitoring visitors within protected and recreational areas, such as modified infrared camera traps. Infrared cameras will be deployed in April 2019 to 27 sites across GB to estimate the monthly and annual visitor numbers which will subsequently be compared to visitor numbers sourced from personal contacts and the literature. These data could be incorporated into, or used to validate, linear regression models to identify the drivers of, and phenology of, NBT within these areas. Visitor count data can also assist managers in making informed decisions and strategic plans with regards to controlling visitor numbers (Reynolds and Elson, 1996).

Chapter 5 will discuss potential management and marketing implications for species which may currently be over or under-utilised as tourism attractors by the WBT resources and for sites which may currently be over or under-utilised by NB tourists, relative to their traits.

Finally, in Chapter 6 the relative importance of species and site attributes which drive tourism in Africa and GB will be compared. Applications of this study and future research suggestions will also be considered.

Chapter 2

The Drivers of Nature-based Tourism Across Africa

2.1 Introduction

Anthropogenic and environmental stressors are placing increasing pressure on the sustainability of natural resources (Abukari and Mwalyosi, 2018; Battersby, 2005). Protected areas (PAs) are designated to safeguard the environment and its services associated with the Total Economic Value framework (TEV; Costanza et al., 1997; Daniel et al., 2012; Gössling, 1999; King et al., 2012; Tisdell and Wilson, 2003). Many of these PAs are important hosts of nature-based tourism (NBT) activities, such as wildlife-watching and trekking (Gössling, 1999), which are associated with cultural ecosystem services according to the TEV framework (Gössling, 1999; Tisdell and Wilson, 2003). Such activities are becoming increasingly popular as people seek the psychological "sense of place" benefits of nature, away from their urbanised, structured lives (Beedie and Hudson, 2003; Curtin and Wilkes, 2005; Gössling, 1999; Urry, 1990; Wolch, West, and Gaines, 1995).

2.1.1 Nature-based Tourism in Africa

This chapter focuses on understanding the drivers of NBT and wildlife-based tourism (WBT), a sub-sector of NBT, within African National Parks (NPs). African NPs are ideal NBT destinations due to the expansive habitats and landscapes, the existence of charismatic megafauna, including the “Big Five”, and the presence of well-established wildlife-tourism operators (Goodwin and Leader-Williams, 2000; Lindsey et al., 2007; Okello, Manka, and D’Amour, 2008). Many NPs, local communities, and countries in Africa rely on tourism revenue (Eagles, 2014; Goodwin and Leader-Williams, 2000; Walpole and Thouless, 2005; Willemen et al., 2015). Thus, the environment relies on tourism for its protection from increased human encroachment, poaching and habitat destruction which are widespread across this developing continent (Abukari and Mwalyosi, 2018; Ferreira, 2004; Lindsey et al., 2007; Myers, 1972; Tapper, 2006). For example, in Tanzania, the Serengeti NP generates US$5.2 million per annum, and the Ngorongoro Conservation areas generate US$5.9 million per annum, from tourism (Thirgood et al., 2006). In addition, African NPs are also thought to act as symbols of national identity and culture (Frost and Hall, 2009), and their importance is widely praised by the television and media, which in turn is though to influence their appeal (Bulbeck, 2005).

NBT, however, can be seen as a "double-edged sword" (Siikamäki et al., 2015), whereby visitor numbers can breach the ecological carrying capacity of a site, engendering negative impacts on the environment, such as the clearing of habitat for tourist facilities and accommodation (Knight and Cole, 1995; Reynolds and Braithwaite, 2001). Likewise, the overstocking of charismatic megafauna and extralimital species at the expense of ecosystem resilience (Maciejewski and Kerley, 2014a; Maciejewski and Kerley, 2014b) can occur when management focuses on satisfying presumed tourist demands (Margules and Pressey, 2000; Akama and Kieti, 2003; Di Minin et al., 2013). Indeed, many sites are thought to be currently over-utilised by tourists (e.g. Amboseli NP, Okello, Manka, and D'Amour, 2008) and could benefit from reduced visitor pressure. Methods of redistributing visitor interest could involve physical restrictions on tourism flow (Orams, 1996a) or the promotion of underutilised parks which currently generate relatively little revenue (Goodwin and Leader-Williams, 2000; Thirgood et al., 2006).

The growth in tourism in Africa, fuelled partially by increased travel and accessibility (Ashley and Elliott, 2003; Christie and Crompton, 2001) is occurring in parallel with increased pressure to conserve the natural environment whilst meeting tourism expectations (Akama and Kieti, 2003; Arbieu et al., 2018). Biodiversity conservation within many African NPs is currently inadequate due to underfunding of park management from government bodies, shown by the existence of "paper parks" (Eagles, 2014; Fjeldsa et al., 2004; Lindsey et al., 2007; Wilkie and Carpenter, 1999a). Clearly, NBT and its social-ecological dynamics play a large part in the management and functioning of NPs (Anderies, Walker, and Kinzig, 2006; Siikamäki et al., 2015; Tapper, 2006). Consequently, sustainably managing tourism within NPs, for the benefit of conservation, requires comprehensive knowledge of what species and site features that attract tourists, as well as an awareness of social and ecological carrying capacities (Ferreira and Harmse, 1999; Ferreira and Harmse, 2014).

2.1.2 Features Which Appeal to Tourists

According to the Leisure Specialisation Continuum (LSC; Bryan, 1977), the NBT market is heterogeneous, with generalists, at one end, having a greater interest in the services and amenities provided by the experience than specialists at the other end (Catlin and Jones, 2010; Duffus and Dearden, 1990). With experience, generalists will gain knowledge and enthusiasm, progressing along the continuum. The factors that intuitively drive individuals to participate in NBT and WBT activities, and influence their behaviours, however, are highly varied (e.g Ajzen, 1988).

Previous findings have shown that tourists are typically attracted to species that are: charismatic (Goodwin and Leader-Williams, 2000; Krüger, 2005; Lorimer, 2006; Lorimer, 2007), large (Coursey, 2010; Ward et al., 1998), threatened (Macdonald et al., 2015), colourful (Stokes, 2007; Lišková and Frynta, 2013), and relatively easy to view (Tremblay, 2002; Prism Environmental Consulting Services, 1988; Reynolds and Braithwaite, 2001). As WBT is considered a non-use value according to the TEV framework (Tisdell and Wilson, 2003), the underlying preferences tourists have for species characteristics have been studied primarily with the use of stated preference techniques, including contingent valuation (CV) and choice experimentation (CE) (Willemen et al., 2015), which are widely criticised as noted in Chapter 1. Such research has typically been restricted to measuring the tourism potential of large bodied mammals, and thus, species management and marketing tends to disregard wider biodiversity in favour of charismatic megafauna and flagship species (Goodwin and Leader-Williams, 2000; Kerley, Geach, and Vial, 2003; Lindsey et al., 2007; Maciejewski and Kerley, 2014a; Maciejewski and Kerley, 2014b; Smith et al., 2012; Wood et al., 2013). These methods are therefore thought to be only partially suitable in terms of providing holistic information on where funding should be directed in terms of conservation of species for tourism purposes (Lew, 2015).

Most tourists are thought to visit large sites (Balmford et al., 2015) with charismatic megafauna (Di Minin et al., 2013; Grünewald, Schleuning, and Böhning-Gaese, 2016; Maciejewski and Kerley, 2014a; Maciejewski and Kerley, 2014b; Okello, Manka, and D'Amour, 2008), savannah habitats (Goodwin and Leader-Williams, 2000; Kellert, 1996), good accessibility and political stability (Akama and Kieti, 2003; Hausmann et al., 2017b; Wilkie and Carpenter, 1999a; Willemen et al., 2015) which are close to areas of human habitation (Balmford et al., 2015; Ghermandi and Nunes, 2012; Neuvonen et al., 2010). Some methods for elucidating site features that attract tourism have involved guesswork (Arnberger and Hinterberger, 2003), stated or revealed preference techniques (e.g. Travel Cost Method; Clawson, 1972), or correlated features with social media hits, as a proxy for visitor numbers (Hausmann et al., 2017b). The latter of which allows for large sample sizes unlike preference techniques; however it is limited by location inaccuracy (Tufekci, 2014) and inconsistent access to social media and camera equipment (Mancini, Coghill, and Lusseau, 2016).

More recently, site features have been correlated with actual visitor numbers (e.g. Balmford et al., 2015). Modelling visitation can assist NP managers in making informed decisions and strategic plans, for example, to attract external funding and advocate investment (Balmford et al., 2015; Eagles, 2014; Ploner and Brandenburg, 2003; Reynolds and Elson, 1996; Phillips, 1998). Visitation data can also be used to generate performance indicators for visitor flow modelling, and therefore can be used to predict the effectiveness of marketing approaches on NBT participation (Phillips, 1998). Thus, it is of great importance to understand what drives tourism visitation to develop sustainability in terms of NBT, park management and conservation.

2.1.3 Chapter Plan

This chapter adopts an alternative method to identify what traits makes species attractive to tourists based upon their popularity within various WBT resources. Site features which appeal to tourists will then be identified, using NP visitor number data.

WBT resources such as guidebooks and brochures are thought to reflect tourist preferences for destinations and associated wildlife (Eagles, Mccool, and Haynes, 2002; Kirkland, 2020; Newhouse, 2017; Reynolds and Braithwaite, 2001), with species of great attractiveness to tourists mentioned most frequently across the resources (Kirkland, 2020; Newhouse, 2017). Unlike contingent valuation and choice experimentation methods, collecting tourist preference data from WBT resources is not subject to yea-saying (Blamey, Gordon, and Chapman, 1999), is not costly or as time consuming, and has wide coverage of taxa and WBT destinations (Hill and Courtney, 2006; Richards and Friess, 2015; Wood et al., 2013). Here, a modelling framework will be built to explore whether species popularity in WBT resources is determined by key features relating to species' visibility, threat, and physical appearance. It is hypothesised that the most popular species will be large-bodied, readily viewable, threatened, evolutionary distinct, group-living, diurnal and physically appealing. Concurrently, the popularity of species will be estimated based upon their characteristics and popularity association, and species which may currently be over- and under-represented by the WBT resources, and therefore NB-tourists, relative to their attributes, will be identified. This study will focus on bird and terrestrial mammal taxa which are suggested to be responsible for attracting tourists to African NPs (Arbieu et al., 2018; Christie and Crompton, 2001; Clucas, McHugh, and Caro, 2008; Kerley, Geach, and Vial, 2003; Lindsey et al., 2007; Maciejewski and Kerley, 2014a; Maciejewski and Kerley, 2014b; Okello, Manka, and D'Amour, 2008; Skibins, Powell, and Hallo, 2016; Smith et al., 2012)

The wildlife popularity of each NP will then be calculated using estimated species lists which will be will be derived using a simplistic approach of intersecting species' distribution maps with NP shapefiles from the World Database on Protected Areas (WDPA). Such distribution maps can inexpensively summarise species distributions (Somveille et al., 2013) and have been used to assess biodiversity within PAs (Rodrigues et al., 2004). Such data has also previously been utilised to predict species lists in similar studies conducted by members of the Conservation Ecology Group (CEG) at Durham University (e.g. former MSc student, Newhouse, 2017, and current PhD student, Kirkland, 2020). The wildlife popularity metric will be defined as the sum of the species popularity metrics for all species estimated to be on a NP species list. A second modelling framework will be built to explore whether visitor numbers are determined by key features relating to wildlife popularity, biogeographical and socioeconomic variables. From reviewing the literature, it is expected that the highest visitor numbers will be associated with well established, large, easily accessible NPs with popular flora and fauna in well developed countries. Consequently, the drivers of NBT across African NPs will be identified, and sites which are currently over- and under-exploited by the tourism industry will be identified. Management implications for such destinations will be discussed in Chapter 5.

2.2 Methodology

2.2.1 Species Popularity

2.2.1.1 Trait Data Collection

A comprehensive list of 2,425 African bird species was extracted from the Handbook of the Birds of the World (HBW) Alive (del Hoyo et al., 2018), and aligned with the avian taxonomies of BirdLife International (BirdLife International, 2017). A second comprehensive list of 1,374 terrestrial African mammal species was extracted from Wilson and Reader (2005), supplemented by the Handbook of the Mammals of the World series (HMW; Mittermeier and Wilson, 2015; Mittermeier and Wilson, 2018; Mittermeier, Wilson, and Rylands, 2013; Wilson, Lacher Jr., and Mittermeier, 2016; Wilson, Lacher Jr., and Mittermeier, 2017; Wilson and Mittermeier, 2009; Wilson and Mittermeier, 2011), and aligned with the mammalian taxonomies of the International Union for Conservation of Nature (IUCN; IUCN, 2016).

The African islands which contribute little to the overall area considered were excluded from this study due to limits on data availability and comparability. By focusing on mainland Africa, island endemicity was prevented from having a confounding effect on the species popularity analyses. Subsets of 2,210 bird species and 310 terrestrial mammal species occurring across mainland Africa were examined in this study. The mammal subset also excluded species of the orders Afrosoricida (golden moles, otter shrews and tenrecs), Chiroptera (bats), Eulipotyphla (gymnures, hedgehogs, shrews), Macroscelidea (sengis) and Rodentia (rodents except spring hares and porcupines). These orders were excluded as limited trait data is available for their species and they contain nocturnal and subterranean species, therefore, they are rarely recognised as important components of the mammal assemblages responsible for attracting WBT. The mammal subset also excluded the dromedary camel, *Camelus dromedaries*, as this species is seen as domesticated, and the Scimitar-horned Oryx, *Oryx dammah*, which, according to the IUCN Red List, is extinct in the wild.

The following trait data for each species were collated previously by the CEG at Durham University. Global extinction risk was classified by the IUCN Red List categories and converted to a continuous scale, with level of risk ranging from 1 ('Critically Endangered') to 5 ('Least Concern'). 'Data Deficient' species were treated as missing observations (Jetz and Freckleton, 2015). Body mass data were extracted from BirdLife International (2017), the CRC handbooks (Dunning Jr, 2007; Silva and Downing, 1995) and the Handbook of the Mammals of the World series (Mittermeier and Wilson, 2015; Mittermeier and Wilson, 2018; Mittermeier, Wilson, and Rylands, 2013; Wilson, Lacher Jr., and Mittermeier, 2016;

Wilson, Lacher Jr., and Mittermeier, 2017; Wilson and Mittermeier, 2009; Wilson and Mittermeier, 2011) and a log_{10} transformation applied to reduce leverage of a relatively small number of heavy species in models. Evolutionary distinctiveness scores, representing the amount of evolutionary history that individual species represent, were extracted from a dataset built by the Zoological Society of London's EDGE of Existence Programme (Jetz et al., 2014).

Species were classified as carnivorous, herbivorous, or omnivorous using datasets from BirdLife International (2017); HBW Alive (del Hoyo et al., 2018), Kissling et al. (2014a), Kissling et al. (2014b); and Wilman et al. (2014). Birds were classified as diurnal or nocturnal principally according to HBW Alive (del Hoyo et al., 2018), augmented with species-specific searches where necessary. Mammals were classified as diurnal, nocturnal, cathemeral or crepuscular using the dataset of Bennie et al. (2014). Species habitat associations were classified by BirdLife International (2017) and The Global Mammal Assessment Programme (2017). Habitats with similar wildlife visibility were combined into single categories by CEG PhD student Kirkland (see Tables A.1 and A.2 in Appendix A).

Mammals were classified as solitary or group living following Lukas and Clutton-Brock (2013), PanTHERIA (Jones et al., 2009), HMW series (Mittermeier and Wilson, 2015; Mittermeier and Wilson, 2018; Mittermeier, Wilson, and Rylands, 2013; Wilson, Lacher Jr., and Mittermeier, 2016; Wilson, Lacher Jr., and Mittermeier, 2017; Wilson and Mittermeier, 2009; Wilson and Mittermeier, 2011), Fischer et al. (2011) and Pearce et al. (2013). Data were extracted principally from del Hoyo et al. (2018) to classify birds as colonial or not colonial, and augmented with species-specific searches where necessary. The migratory tendencies of bird species were classified using BirdLife International (2017) categories, and were converted to an ordinal scale, ranging from 'Non-migrant' (1), 'Altitudinal migrant' (2), 'Nomadic' (3), or 'Full migrant' (4). The selected traits reflect factors known (e.g. body mass, Clucas, McHugh, and Caro, 2008; Coursey, 2010; Lorimer, 2007; Reynolds and Braithwaite, 2001; Veríssimo et al., 2017; Ward et al., 1998) or suspected (e.g. time partitioning) to influence the tourism-potential of species.

The following trait data, additional to those compiled previously, were collated as part of this project. As only mainland Africa was considered in this study, bird and mammal species breeding range distribution polygons were obtained from BirdLife International (2017) and the IUCN (2016), respectively, and cropped to include only species' range extent across mainland Africa. These polygons were transformed from an un-projected coordinate system to an equal area grid, in Behrman projection, with a cell size of 1° longitude at 30° North/South and range extent estimated by calculating the total area of the species range polygons across mainland Africa using 'rgeos' and 'rgdal' packages in R (Fritz and Rahbek, 2012; Newhouse, 2017; Orme et al., 2005; R Development Core Team, 2019). The African range of the Eurasian Golden Jackal, *Canis aureus*, was used as an estimate for the range size of the African Wolf, *Canis lupaster* (IUCN, 2018). A log_{10} transformation was applied to the range size data to account for skew.

Data describing the physical appearance of birds and mammals were extracted from species illustrations from HBW and BirdLife International's *'Illustrated Checklist of the Birds of the World'* (del Hoyo and Collar, 2014), and the HMW Series (Mittermeier and Wilson, 2015; Mittermeier and Wilson, 2018; Mittermeier, Wilson, and Rylands, 2013; Wilson, Lacher Jr., and Mittermeier, 2016; Wilson, Lacher Jr., and Mittermeier, 2017; Wilson and Mittermeier, 2009; Wilson and Mittermeier, 2011), respectively. Mammal data were extracted by CEG BSc project student, Hart. Physical appearance data were derived from the male illustration of each species as, with very few exceptions (e.g. dotterel, *Eudromias morinellus*), males tend to be the most brightly coloured, ornately patterned and ornamented of the sexes. The appearance data extracted were chosen to reflect those features known (e.g. colouration and patterning, Frynta et al., 2010a; Lišková and Frynta, 2013; Prokop and Fančovičová, 2013; Stokes, 2007), or suspected (e.g. unusual adornments and appendages) to influence the tourism-potential of species, without introducing subjectivity of those collating the data (e.g. judgement of beauty, Roque De Pinho et al., 2014; Frynta et al., 2011). A Bright Colour Index (BCI), a modified variant of the World Bank's *Poverty Gap Index* (Haughton and Khandker, 2009) was derived for each bird species to reflect the potential appeal of bright and iridescent colouration (e.g. Barua et al., 2012; Lišková and Frynta, 2013). The BCI considers how far, on average, the plumage colouration exceeds a threshold brightness or iridescence, as the intensity of colours is presumed to be a stronger driver of species popularity than colour richness alone. The BCI was not calculated for mammal species as most do not express bright or iridescent colouration. Documents describing the physical appearance data that were extracted from images of males of all African bird and terrestrial mammal species, originally created by former CEG project students can be found in Appendix A section A.2. Section A.1.3 in Appendix A provides examples of three bird species with high, medium and low BCI values. Table 2.1, below, describes the combined selection of physical traits which were considered in the analyses.

Many species had missing trait values (Table 2.2) therefore, to prevent an introduction of bias through reduced sample size (Nakagawa and Freckleton, 2008), PhD student Kirkland (2020) imputed missing values through maximum-likelihood estimations based on a covariance matrix determined by phylogenetic and phenotypical correlations using phylogenetic trees and R package 'Rphylopars' (Goolsby, Bruggeman, and Ané, 2017; R Development Core Team, 2019). Species which still had missing values for at least one trait even after imputation were excluded from analyses.

2.2.1.2 Species Popularity Scoring

Site-specific mentions of birds and terrestrial mammals were extracted from WBT resources and compiled with records collated by additional members of the CEG (Table 2.3), with the assumption that species mentioned more frequently across the resources would be the most popular tourist attractants. Subspecies were recorded at their species level due to the lack of trait data available for subspecies. In total, 15,094 records of birds

TABLE 2.1: Details of the physical appearance data that were extracted for birds and mammals

Trait	Definition
Colour richness	The number of colours on a species, including features, fur and bare skin, as defined in Appendix A section A.2
Bright Colour Index	$$BCI = \frac{1}{N}\sum_{j=1}^{q}\frac{z-y_j}{z} \quad (2.1)$$ • N = the sum of colour values expressed by a species with all colours present on a species ranging on an intensity scale from dark (1), dull (2), pale (3), medium (4), bright (5), to iridescent (6) • q = the total number of colours above the medium intensity value of 4 • z = the medium intensity value of 4 • y_j = the value of the colour above the medium intensity value of 4, j *In this calculation, colours at or below the medium value of 4 have a value of 0*
Distinct patterning	Presence of one or more of the following features: • Prominent patches • Head patterning • Vermiculation, spots, stripes, streaks, speckles
Unusual appendages	Presence of one or more of the following features: • For birds only: – Large bill (approx. body length or longer) • For mammals only: – Large eyes (25% of the length between the muzzle tip and the base of the pinna) – Large ears (length >50% of the surface area of half of the face) • For both birds and mammals: – Long legs (approx. body length or longer) – Long neck (approx. body length or longer) – Long tail (approx. body length or longer)
Unusual adornments	Presence of one or more of the following features: • For birds only: – crest, ornamental bill, wattle, hackles, gular pouch • For mammals only: – mane, horns, antlers, elongated proboscis, ossicones

and 11,764 records of terrestrial mammals were extracted from the WBT resources. Many resources had duplicate mentions of species, therefore, to prevent over-representation,

TABLE 2.2: The number of species trait data points that were available and the number of species trait data points which were imputed by CEG student, Kirkland (2020).

	Birds		**Mammals**	
Trait	**Observed**	**Imputed**	**Observed**	**Imputed**
log_{10} body mass	1936	145	287	18
log_{10} range size	2209	1	299	11
Evolutionary distinctiveness	2079	N/A	293	15
Extinction risk	2191	15	293	17
Habitat association	2120	N/A	297	12
Trophic level	2079	N/A	299	11
Time partitioning	2210	N/A	295	14
Coloniality	2120	1	N/A	N/A
Migratory tendancy	2210	N/A	N/A	N/A
Sociality	N/A	N/A	255	45
Colour richness	2210	N/A	310	N/A
Bright Colour Index	2210	N/A	N/A	N/A
Distinct patterning	2210	N/A	310	N/A
Unusual adornments	2210	N/A	310	N/A
Unusual appendages	2210	N/A	310	N/A

the popularity index of each species was determined only by the total number of resources a species was mentioned in, rather than the total number of times it was mentioned. This approach partially controlled for the fact that more widespread species tend to be mentioned more often just because they occur at more sites than rarer species.

TABLE 2.3: List of the WBT resources from which site-specific species mentions were recorded

Resource type	**Resource**
Book	Beletsky (2010), Global Birding: Travelling the World in Search of Birds. National Geographic, USA.
	Brodowsky and The National Wildlife Federation (2009), Destination Wildlife. Perigree Trade, USA.
	Burrard-Lucas and Burrard-Lucas (2015), Top Wildlife Sites of the World. New Holland Publishers Pty Ltd., UK.
	Carwardine (2011), Ultimate Wildlife Experiences. Wanderlust Publications Ltd., UK.
	Couzens (2013), Top 100 Birding Sites of the World. New Holland Publishers Pty Ltd., UK.
	Garbutt (2007), 100 Animals to see before they die. Bradt Travel Guides, UK.
	Gray (2012), Wildlife Travel. Footprint Travel Guides, UK.
	Holing and Baker (1996), Nature Journeys. Harper Collins, UK.
	Lukas (2009), A Year of Watching Wildlife. Lonely Planet, USA.
	Parry (2007), Global Safari. Carlton Books Ltd., UK.
	Riley and Riley (2005), Nature's Strongholds: The World's Great Wildlife Reserves. Princeton University Press, USA.
	Santolalla (2006), Parques y Reservas del Mundo. Guia de los Mejores Espacios Naturale, Ducable Libros, Spain.
	Wilson (2016), Ultimate Wildlife Destination. New Holland Publishers Pty Ltd., UK.
	Wood (2012), Swimming with Dolphins, Tracking Gorilla. Bradt Travel Guides Ltd., UK.
Regional Guide	Baranowski (2018), The Complete Guide to African Safaris. Fodor's Travel Guides, Ltd., UK.
	Bradt Travel Guides; Unwin (2011), Southern African Wildlife; Briggs and Zandbergen (2016), East African Wildlife, Bradt Travel Guides, Ltd., UK.
	Lonely Planet Travel Guides; Firestone et al. (2009), Watching Wildlife East Africa; Hunter, Rhind, and Andrew (2002), Watching Wildlife Southern Africa, Lonely Planet Publicatinos Pty Ltd., Australia.
	Wheatley (2014), Where to Watch Birds in Africa (Vol. 330). Princeton University Press, USA.

Brochure	Heatherlea Birding and Wildlife Holidays (2017) Natural World Safaris (2017) Naturetrek Birdwatching, Botanical & Natural History Holidays (2017) Naturetrek Tailormade Bespoke Wildlife and Cultural Holidays Crafted by Experts (2017) Ornitholodays (2017) Rockjumper Worldwide Birding Adventures (2017) Speyside Wildlife (2017) The Travelling Naturalist Birdwatching and Wildlife Holidays Worldwide (2017/18) Wildlife Worldwide Winter/Spring (2017)
Website	Exodus Travel (available at www.exodus.co.uk) Exsus (available at www.exsus.com) Mammal Watching (available at www.mammalwatching.com) Natural Habitat Adventures and WWF (available at www.nathab.com) Wildwings (available at www.wildwings.co.uk)

2.2.1.3 Statistical Analysis

Complete trait data were available for 2,034 bird species and 300 terrestrial mammal species. Of these species, 1,754 birds and 257 mammals were mentioned across the WBT resources. Former MSc student Newhouse (2017) and current PhD student Kirkland (2020) adopted two modelling approaches to assess species popularity. Binary models were fitted to predict whether species were mentioned, or not, by the resources, and count-based models were fitted to predict the popularity scores only for species which were mentioned in at least one resource. The two approaches generally showed the same results, therefore, and further due to time constraints, analyses in this study were only conducted on the species which were mentioned in at least one resource (relevant data for these species can be found in Appendix A section A.2).

To explore the relationship between the number of resources in which species were mentioned and potential explanatory variables, negative binomial generalized linear mixed-effects models (GLMMs) were fitted to the bird data using the R package 'MASS' (R Development Core Team, 2019). Model comparison using the Akaike Information Criterion (AIC) showed that the inclusion of phylogenetic order as a random effect improved the fit of the bird GLMM. Negative binomial generalized linear models (GLMs) were fitted to the mammal data using the R Package 'MASS' (R Development Core Team, 2019). Model comparison using the AIC showed that the inclusion of phylogenetic order as a random effect did not improve the fit of the mammal GLMM and there was little variance in the response between the mammalian taxonmic orders after accounting for fixed effects (SD = <0.0001). All covariates were centred and standardised. There was no evidence of collinearity between the explanatory variables.

The global negative binomial GLMM for exploring the popularity of bird species across WBT resources included extinction risk, body mass, evolutionary distinctiveness, trophic level, time partitioning, habitat association, coloniality, migratory tendancy, colour richness, Bright Colour Index, distinct patterning, unusual appendages and unusual adornments. The global GLM for exploring the popularity of mammal species across the WBT resources included extinction risk, body mass, evolutionary distinctiveness, trophic level, time partitioning, habitat association, sociality, colour richness, distinct patterning, unusual appendages and unusual adornments.

Using the 'MuMIn::dredge' function in R (Barton, 2009), all possible combinations of explanatory variables were considered in a model selection framework to produce a set of candidate models. These models were evaluated by comparing model complexity and fit, using the number of variables and their AIC (Burnham and Anderson, 2002). Following Richards (2008), all models with ΔAIC<6 were considered, and more complex models with higher ΔAIC than all simpler nested models were removed. More complex models with lower ΔAIC than simpler nested models were retained, following Richards (2008). A single best model was indicated by an AIC weight of >0.9 (Burnham and Anderson, 2002). When there was no single best model, the full model average of the top performing models was calculated using the 'MuMIn:model.avg' function (Barton, 2009), as a method of multi-model inference to explore the effect of each predictor variable on the response (Burnham and Anderson, 2002). Model averages were subsequently used to predict the popularity of all bird and mammal species. Residual values were calculated by subtracting the predicted popularity index from the observed popularity index. Species that might currently be overlooked as tourism attractors by the WBT resources, relative to their traits, were identified by negative residual values.

2.2.2 Tourism within National Parks

2.2.2.1 Trait Data Collection

A comprehensive list of 334 completely or partially terrestrial NPs with polygon outlines across mainland Africa was extracted from The World Database on Protected Areas (WDPA; UNEP-WCMC and IUCN, 2019). For each NP, data were compiled on: site area, age (years since establishment), habitat diversity, primary habitat type, local population catchment size, accessibility, wildlife popularity, species richness and the level of human development of the host country, as detailed below. These selected traits reflect features known (e.g. area, Balmford et al., 2015) or suspected (e.g. wildlife popularity) to influence tourists' decisions when choosing a NBT destination.

NP area and year of establishment were extracted from the WDPA (UNEP-WCMC and IUCN, 2019). Area was log_{10} -transformed to reduce leverage of a relatively small number of large sites in models. Age of NP was calculated by subtracting the year of establishment from 2020. The following data for NPs were collated previously by PhD student Kirkland. Habitat diversity and primary habitat type were extracted from the European Space Agency (2009) GlobCover dataset. Accessibility was defined as the mean travel time to the closest major city of $>$50,000 people based on the global accessibility map of Weiss et al. (2018), with values closer to zero reflecting the most accessible sites. Size of the local catchment population within a 100km buffer of each NP was calculated using the Gridded Population of the World (GPWv4; Center for International Earth Science Information Network, 2017). The Human Development Index (HDI) of each host country was extracted from the World Bank Group (2016).

Following this, the wildlife popularity of each NP was calculated using estimated species lists and the actual popularity indices of each species calculated in the first part of the study, defined as the number of WBT resources each species was mentioned in. As species lists are of limited availability (Balmford et al., 2015), species lists were estimated by overlaying NP polygon data from the WDPA UNEP-WCMC and IUCN (2019) and species range polygon data from BirdLife International (2017) and the IUCN (2016), using the 'rgdal', 'raster', 'rworldmap' and 'rgeos' packages in R (R Development Core Team, 2019). A species was included on a NP species list if the species polygon intercepted the NP polygon. This method was utilised by former CEG MSc student, Newhouse (2017) and current PhD student, Kirkland (2020). Newhouse (2017) demonstrated the validity of this method by collating actual species lists for global PAs and compared the similarity between the two datasets using the Jaccard similarity coefficient (Niwattanakul et al., 2013). Wildlife popularity was used in preference to separate cumulative mammal popularity and cumulative bird popularity metrics as the two were strongly correlated (r_{67} = 0.7060, p<0.0001). Species richness, defined as the number of species found in each NP was also extracted using the species lists.

2.2.2.2 Annual Visitor Numbers

Following the approach of Balmford et al. (2015), mean annual visitor number data to African mainland NPs were collated from peer-reviewed and grey literature, online datasets and from correspondence with national government departments responsible for natural resource management (data can be found in Appendix A section A.2).

2.2.2.3 Statistical Analysis

Complete trait data were available for 233 NPs (Table 2.4; data can be found in Appendix A section A.2). Analyses were conducted on the 69 NPs for which annual visitation data were sourced. Visitor numbers were log_{10}-transformed to account for skew. Generalized linear models (GLMs) were fitted to explore the relationship between visitor numbers and the various potential explanatory variables described above in R (R Development Core Team, 2019). All covariates were centred and standardised. The only evidence of collinearity between the explanatory variables was between wildlife popularity and species richness (r_{67} = 0.9460, p<0.0001). This was expected as NPs with a greater number of species have a greater number of popularity values to sum together. In this study, species richness was excluded in order to utilise the new-found metric of wildlife popularity.

TABLE 2.4: The number of African NPs, within the subset considered in this study, for which trait data were available.

Trait	**Number of NPs with trait data available**
log_{10} area	334
Age	307
Accessibility	265
Local population catchment	234
Habitat diversity	234
Primary habitat type	234
Human Development Index	334
Wildlife popularity	329
Species richness	329

The global GLM for exploring the observed annual visitor numbers to NPs included area, age, habitat diversity, primary habitat type, accessibility, local catchment population size, HDI of the host country, and wildlife popularity, using Gaussian error structure.

The model selection and model-averaging framework described previously was applied to this data. Due to the limited sample size of visitation data, only model combinations with <6 degrees of freedom were considered in the model selection process to prevent overfitting. The full model-average was used to predict the number of tourists expected to visit each of the 233 NPs, for which complete trait data were available, annually. For sites for which annual visitor numbers had been sourced, the predicted values were subtracted from the recorded values to calculate residual values, which could indicate sites that are currently under- or over-utilised by nature-based (NB) tourists, relative to their features.

2.3 Results

2.3.1 Species Popularity

Table A.4 in Appendix A describes the results of the global GLMM for bird popularity within the WBT resources. Figure A.4 in Appendix A shows that there is some variance in the response between the avian taxonomic orders (SD = 0.2904), after accounting for fixed effects. The model selection process yielded three top performing negative binomial GLMMs which best explained the popularity of African bird species across the WBT resources and they included nine of the 14 attributes (Table 2.5).

TABLE 2.5: The top performing negative binomial GLMMs from the model selection process, used to predict African bird popularity. All models with ΔAIC< 6 were considered. Complex models with lower ΔAIC than simpler nested models were retained, following Richards (2008).

Model rank	Variables in model	AICc	ΔAIC	weight	df
1	African range size + evolutionary distinctiveness + extinction risk + habitat association + body mass + migratory tendency + Bright Colour Index + unusual appendages	6355.5680	0.0000	0.8891	16
2	African range size + colour richness + evolutionary distinctiveness + extinction risk + habitat association + body mass + migratory tendency + unusual appendages	6360.9499	5.3819	0.06030	16
3	African range size + evolutionary distinctiveness + extinction risk + habitat association + body mass + migratory tendency + unusual appendages	6361.3004	5.7324	0.0506	15

The model-averaged GLMM indicated that body mass was the strongest significant (p<0.0500) predictor of African bird popularity, i.e. the greater the mass, the more WBT resources a species was mentioned in (Fig. 2.1, see Table A.5 in Appendix A). Additional variables which had a significant positive influence on species popularity were African range size, the presence of unusual appendages and evolutionary distinctiveness. Extinction risk was also found to significantly influence bird popularity, with those at greater risk being mentioned more often than those less at risk. Non-migratory birds were found to be significantly more popular than species with a greater tendency to migrate. Birds associated with open and forest habitats tended to be least popular. Colour richness and BCI were retained after the model selection process, suggesting that, despite the non significance, these variables somewhat have an effect on species popularity. Trophic level, time partitioning, coloniality and the presence of distinct patterning and unusual adornments were not found to influence the number of resources species were mentioned in.

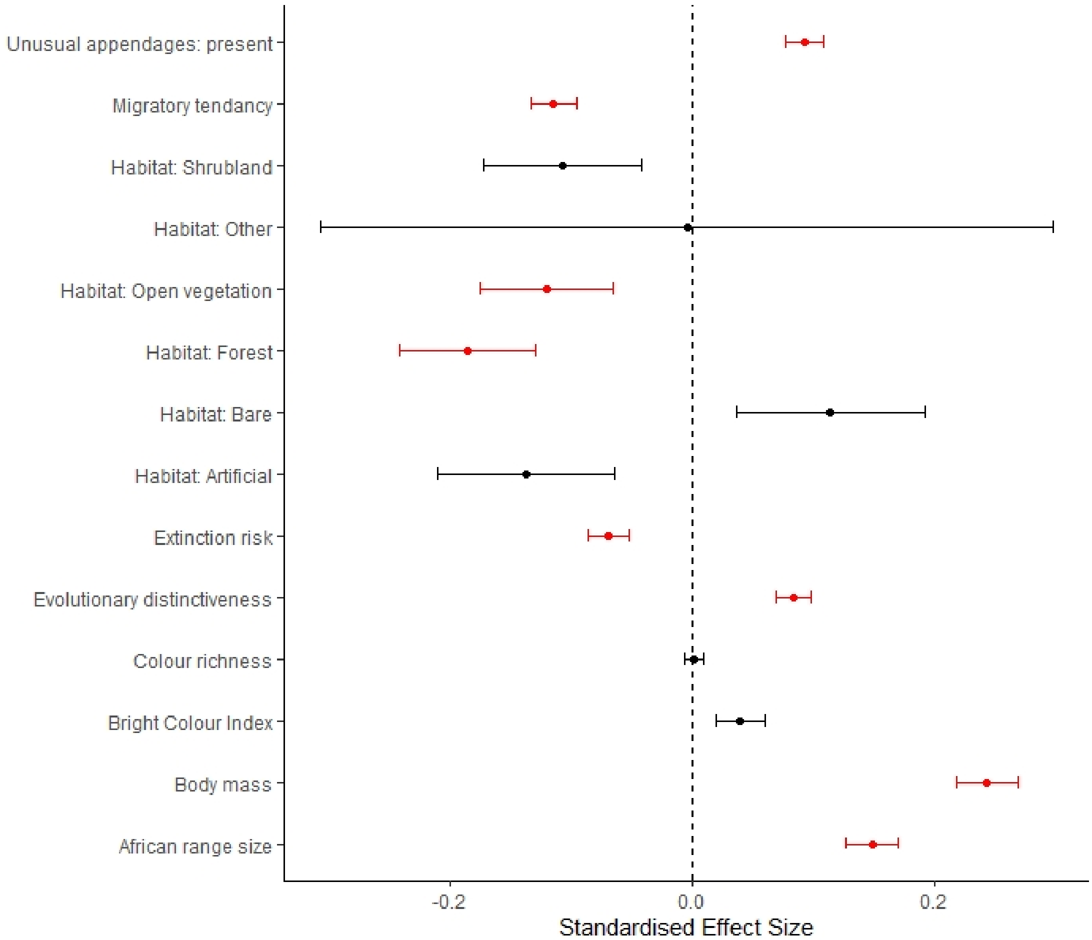

FIGURE 2.1: Standardised effect sizes of the model-averaged GLMM fixed effect coefficients for African bird popularity. Habitat association estimates were relative to the effect species occupying aquatic habitats. The estimate for the presence of unusual appendages was relative to the effect of the absence of unusual appendages. P values significant at 5% levels are shown in red.

Table 2.6 shows the birds with the highest popularity scores, based on the number of times such species were mentioned across the WBT resources, the species with the highest predicted popularity scores derived from the model averaged GLMM, and the species with the highest and lowest residual scores calculated by subtracting the predicted popularity from the actual popularity. Species with the largest negative residuals are suggested to be under-represented by the resources, and species with the largest positive residuals are suggested to be over-represented by the resources, relative to their traits. The R^2 for the top performing model was 0.4590, indicating strong correlation between observed and predicted popularity, following Cohen (1988) (Fig. 2.2).

TABLE 2.6: The top ten ranking African bird species based upon the actual number of resources species were mentioned in, the predicted number of WBT resources species were mentioned in, and the highest and lowest residual values. The predicted values were estimated by the model averaged GLMM. Residual values were calculated by subtracting the number of resources species were predicted to be mentioned in from the actual number of resources species were mentioned in.

Rank	**Species mentioned most in the resources**	**Resources mentioning species (no. of mentions)**	**Species with highest predicted mentions**	**Predicted source mentions**	**Species with largest negative residuals**	**Residuals**	**Species with largest positive residuals**	**Residuals**
1	Pel's fishing-owl *Scotopelia peli*	21	Common ostrich *Struthio camelus*	20.22	Egyptian vulture *Neophron percnopterus*	-7.11	Pel's fishing-owl *Scotopelia peli*	15.73
2	Shoebill *Balaeniceps rex*	19	Secretarybird *Sagittarius serpentarius*	17.69	Rose-ringed parakeet *Psittacula krameri*	-4.55	African fish-eagle *Haliaeetus vocifer*	9.89
3	Lesser flamingo *Pheoniconaias minor*	18	Shoebill *Balaeniceps rex*	16.51	Slender-billed curlew *Numenius tenuirostris*	-4.54	Kori bustard *Ardeotis kori*	9.84
4	Common ostrich *Struthio camelus*	18	Lesser flamingo *Pheoniconaias minor*	12.73	Black crowned-crane *Balearica pavonina*	-4.23	Southern carmine bee-eater *Merops nubicoides*	9.31
5	African fish-eagle *Haliaeetus vocifer*	17	Rüppell's vulture *Gyps ruepelli*	12.21	Rüppell's vulture *Gyps rueppelli*	-4.21	Martial eagle *Polemaetus bellicosus*	8.67
6	Martial eagle *Polemaetus bellicosus*	17	Greater flamingo *Phoenicopterus roseus*	12.03	Black-tailed godwit *Limosa limosa*	-4.06	African skimmer *Rynchops flavirostris*	8.66
7	Secretarybird *Sagittarius serpentarius*	17	Bearded vulture *Gypaetus barbatus*	10.93	Greyish eagle-owl *Bubo cinerascens*	-3.95	African finfoot *Podica senegalensis*	7.97
8	Greater flamingo *Phoenicopterus roseus*	16	Pink-backed pelican *Pelecanus reufescens*	10.79	Fox kestrel *Falco alopex*	-3.88	Great blue turaco *Corythaeola cristata*	7.59
9	Kori bustard *Ardeotis kori*	16	Grey crowned-crane *Balearica regulorum*	10.38	Hadada ibis *Bostrychia hagedash*	-3.86	Slaty egret *Egretta vinaceigula*	7.28
10	Wattled crane *Bugeranus carunculatus*	16	Egyptian vulture *Neophron percnopterus*	10.11	Slender-billed starling *Onychognathus tenuirostris*	-3.85	Black bee-eater *Merops gularis*	7.22

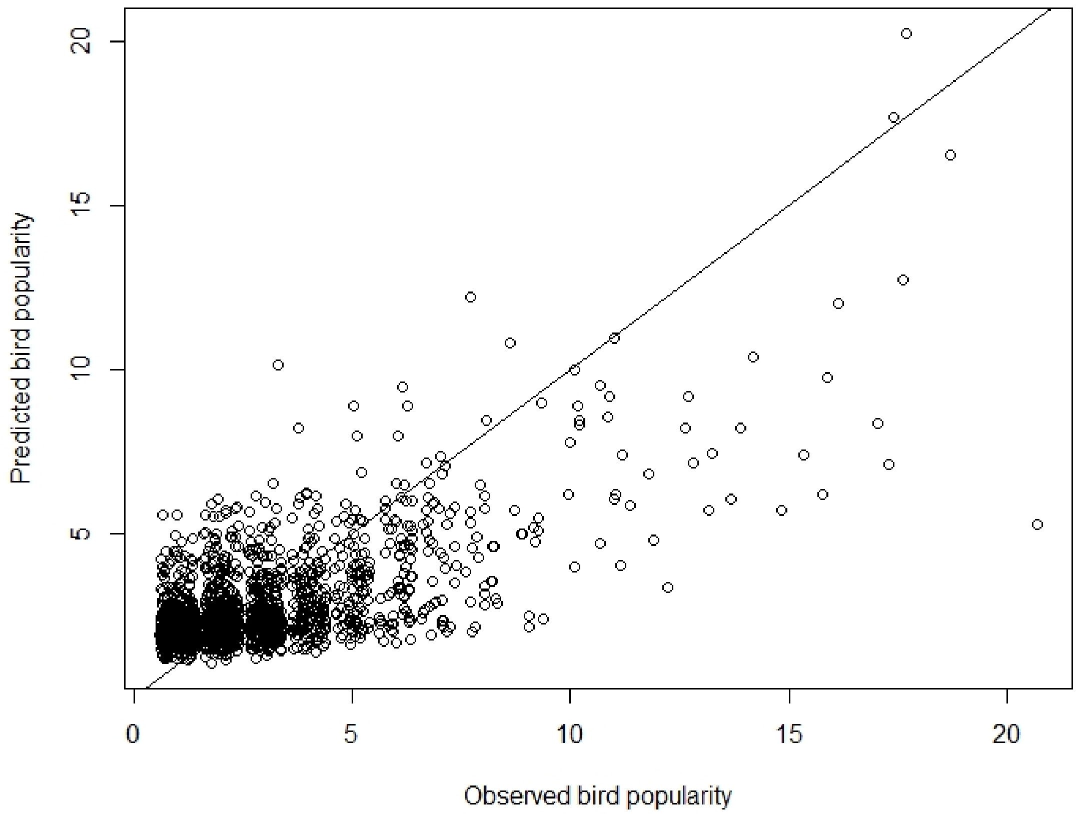

FIGURE 2.2: The relationship between the observed popularity of African bird species, based on the number of WBT resources they were mentioned in, and the predicted popularity of such species based upon the top performing GLMM. Plotted using a jitter function with a factor of 2. Reference (Y=X) line shown.

Table A.6 in Appendix A describes the results of the global GLM for mammal popularity within the WBT resources. The model selection process yielded nine top performing GLMs which best explained the popularity of mammal species across the WBT resources, including seven of the 12 attributes (Table 2.7).

Similar to the African bird results, the model-averaged GLM for mammal species indicated that body mass was the strongest significant (p<0.05) predictor of mammal popularity (Fig. 2.3, see Table A.7 in Appendix A). African range size was also found to have a strong significant positive effect on the number of resources mammals were mentioned in. Solitary mammals were found to be significantly less popular than group-living species. Mammals associated with open, forest and mosaic habitats tended to be most popular, unlike bird species, though the effect of habitat association was not significant. The presence of distinct patterning was positively associated with popularity (though not significantly), whereas the presence of unusual appendages and adornments was negatively associated with popularity (also not significantly). Trophic level, time

TABLE 2.7: Top performing GLMs from the model selection process, whose averages were used to predict African mammal popularity scores. All models with ΔAIC<6 were considered. Complex models with lower ΔAIC than simpler nested models were retained, following Richards (2008).

Model rank	Variables in model	AICc	ΔAIC	weight	df
1	African range size + distinct patterning + body mass + sociality + unusual adornments + unusual appendages	1421.4364	0.0000	0.3738	8
2	African range size + habitat association + body mass + sociality + unusual adornments + unusual appendages	1422.7047	1.2683	0.1983	10
3	African range size + body mass + sociality + unusual adornments + unusual appendages	1423.4502	2.0138	0.1366	7
4	African range size + distinct patterning + body mass + sociality + unusual appendages	1424.2869	2.8505	0.0899	7
5	African range size + Distinct patterning + body mass + sociality + unusual adornments	1425.1624	3.7261	0.0580	7
6	African range size + habitat association + body mass + sociality + unusual appendages	1425.1643	3.7280	0.0580	9
7	African range size + body mass + sociality + unusual adornments	1426.2683	4.8320	0.0334	6
8	African range size + body mass + sociality + unusual appendages	1426.5782	5.1418	0.0286	6
9	African range size + distinct patterning + body mass + sociality	1426.9632	5.2669	0.0236	6

partitioning, extinction risk, evolutionary distinctiveness and colour richness were not found to influence the number of WBT resources species were mentioned in.

Table 2.8 shows the mammal species with the highest popularity scores, based upon the number of WBT resources such species were mentioned in, the species with the highest predicted popularity scores derived from the model-averaged GLM, and the species with the highest and lowest residual scores calculated by subtracting the predicted popularity from the actual popularity. The R^2 for the model-average was 0.4970, indicating strong correlation between observed and predicted popularity (Fig. 2.4; Cohen, 1988).

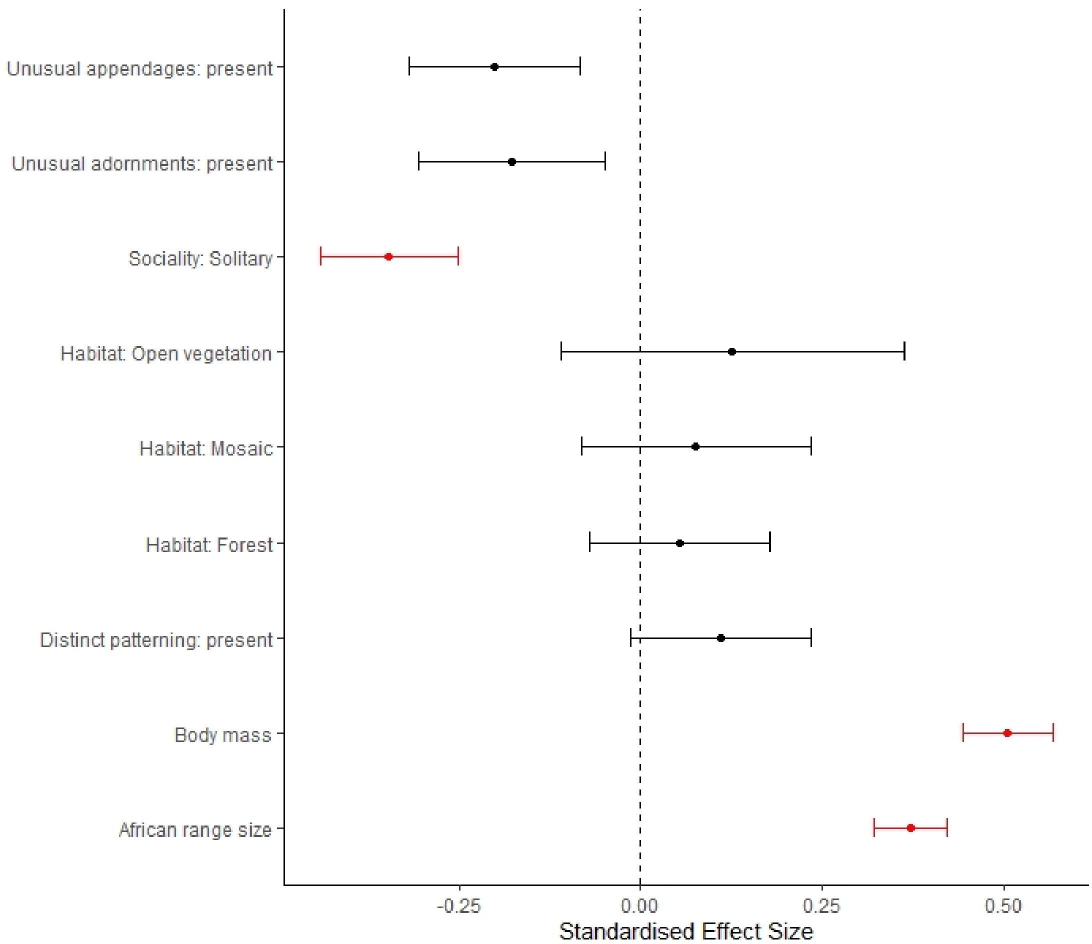

FIGURE 2.3: Standardised effect sizes of the model-averaged GLM coefficients for African mammal popularity. Habitat association estimates were relative to the effect of species occupying bare habitats. The estimate for solitary species was relative to the effect of group-living species. The estimate for the presence of unusual appendages, unusual adornments and distinct patterning were relative to the effect of the absence of these traits. P values significant at 5% levels are shown in red.

TABLE 2.8: The top ten ranking African mammal species based upon the actual number of resources species were mentioned in, the predicted number of resources species were mentioned in, and the highest and lowest residual values. The predicted values were estimated by model-averaged GLM. Residual values were calculated by subtracting the number of resources species were predicted to be mentioned in from the actual number of resources species were mentioned in.

Rank	**Species mentioned most in the resources**	**Resources mentioning species (no. of mentions)**	**Species with highest predicted mentions**	**Predicted source mentions**	**Species with largest negative residuals**	**Residuals**	**Species with largest positive residuals**	**Residuals**
1	African elephant *Loxodonta africana*	28 (657)	Common hippopotamus *Hippopotamus amphibius*	30.13	African forest elephant *Loxodonta cyclotis*	-22.32	Eastern gorilla *Gorilla beringei*	17.72
2	Leopard *Panthera pardus*	28 (445)	White rhinoceros *Ceratotherium simum*	27.34	Giant eland *Tragelaphus derbianus*	-15.34	Leopard *Panthera pardus*	15.34
3	Eastern gorilla *Gorilla beringei*	28 (69)	African forest elephant *Loxodonta cyclotis*	26.32	Lichtenstein's hartebeest *Alcelaphus lichtensteinii*	-11.84	Chimpanzee *Pan troglodytes*	13.94
4	Lion *Panthera leo*	27 (501)	African elephant *Loxodonta africana*	26.19	Red hartebeest *Alcelaphus caama*	-11.76	Cheetah *Acinonyx jubatus*	13.32
5	Common hippopotamus *Hippopotamus amphibius*	27 (367)	African buffalo *Syncerus caffer*	25.09	Bohor reedbuck *Redunca redunca*	-11.34	African wild dog *Lycaon pictus*	13.25
6	Chimpanzee *Pan troglodytes*	27 (154)	Common eland *Tragelaphus oryx*	22.99	Wild boar *Sus scrofa*	-11.25	Blue Monkey *Cercopithecus mitis*	13.12
7	African buffalo *Syncerus caffer*	25 (465)	Waterbuck *Kobus ellipsiprymnus*	21.73	Kinda baboon *Papio kindae*	-9.06	Ethiopian wolf *Canis simensis*	11.80
8	Giraffe *Giraffa camelopardalis*	25 (408)	Spotted hyena *Crocuta crocuta*	21.32	Nile lechwe *Kobus megaceros*	-8.29	Meerkat *Suricata suricatta*	11.60
9	Cheetah *Acinonyx jubatus*	25 (284)	Plains zebra *Equus quagga*	21.28	Bongo *Tragelaphus eurycerus*	-7.77	Guereza *Colobus guereza*	11.47
10	African wild dog *Lycaon pictus*	25 (199)	Greater kudu *Tragelaphus strepsiceros*	21.18	Red-fronted gazelle *Eudorcas rufifrons*	-6.92	L'hoest's monkey *Allochrocebus lhoesti*	11.28

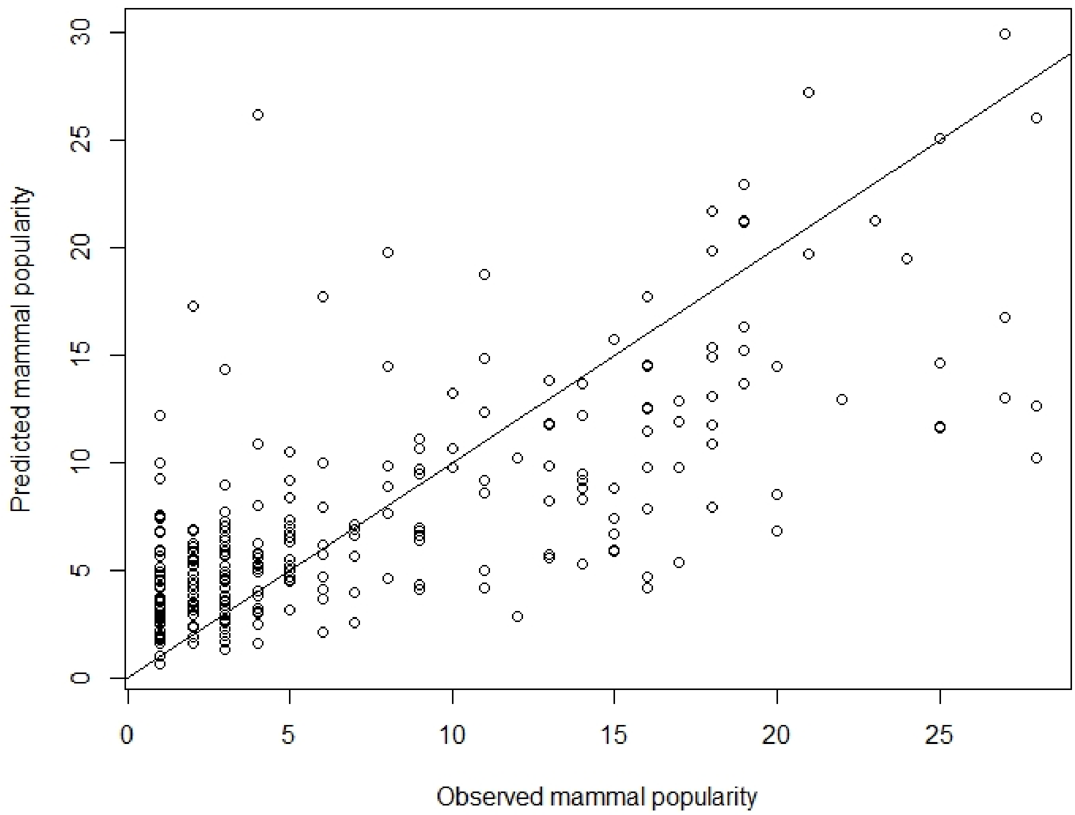

FIGURE 2.4: The relationship between the observed popularity of African mammal species, based upon the number of WBT resources they were mentioned in, and the predicted popularity of such species based upon the model averaged GLM. Reference (Y=X) line shown.

2.3.2 Tourism within National Parks

Table A.8 in Appendix A describes the results of the global GLM for NP visitation. The model selection process yielded two top performing GLMs which best explained the observed annual visitor numbers of African NPs and it included five of the eight attributes (Table 2.9).

TABLE 2.9: The top performing GLMs from the model selection process, used to predict African NP visitor numbers. All models with ΔAIC<6 were considered following Richards (2008).

Model rank	**Variables in model**	**AICc**	**ΔAIC**	**weight**	**df**
1	Age + wildlife popularity + HDI + habitat diversity	147.8367	4.5611	0.5254	6
2	Wildlife popularity + accessibility + HDI + habitat diversity	148.0397	4.7642	0.4746	6

The model-averaged GLM for African NPs indicated that the level of the host country's Human Development Index was the strongest significant ($p<0.05$) predictor of NP visitation (Fig. 2.5, Table A.9 in Appendix A). Sites in more developed countries tend to gain more visitors. Habitat diversity and wildlife popularity were also found to have significant positive effects on visitation, with sites that possess greater habitat diversity and wildlife popularity attracting the most tourists. Years since establishment (age) was found to have small, and not significant, influence on visitor numbers, with older parks attracting more visitors than recently established parks. Accessibility, relating to travel time, was found to have a negative effect on visitation, with more remote sites attracting fewer visitors, though this was not significant. Primary habitat type, area and the size of the local catchment population were not found to influence the number of tourists visiting African NPs.

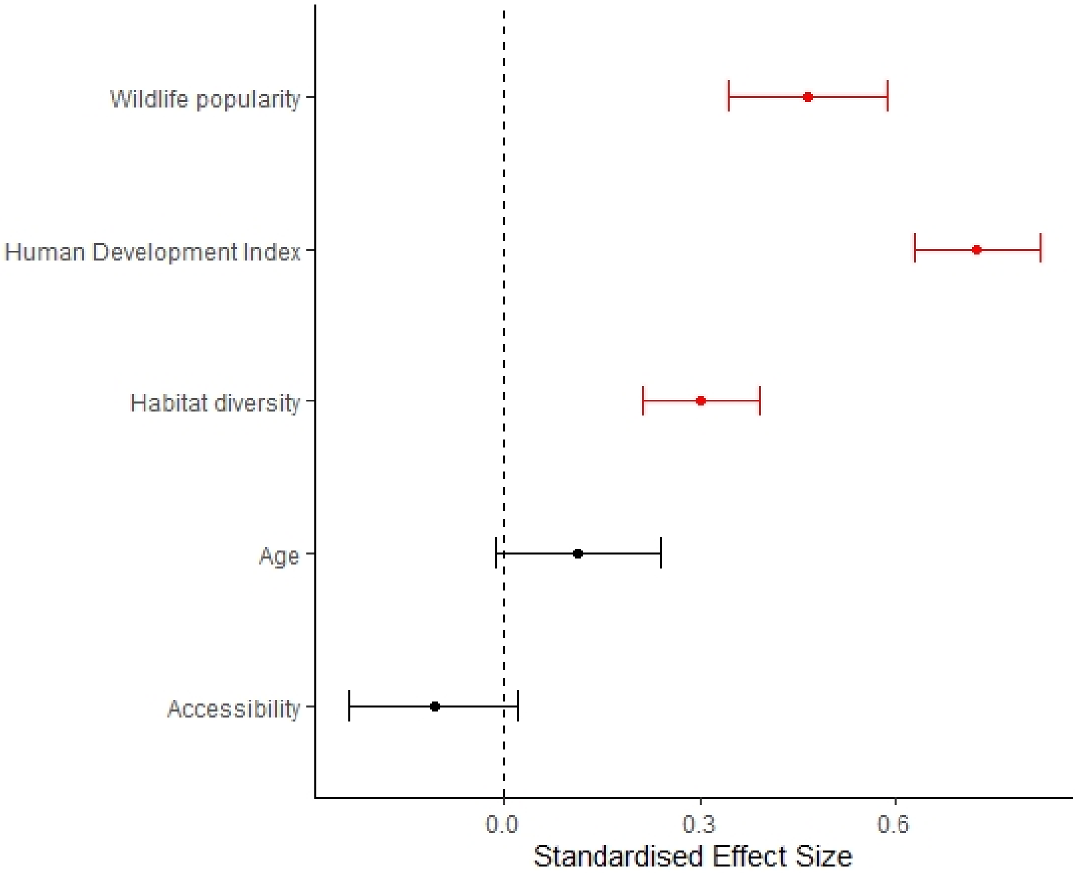

FIGURE 2.5: Standardised effect sizes of the model-averaged GLM fixed effect coefficients for African NP visitation. P values significant at 5% levels are shown in red.

Table 2.10 shows the African NPs with the greatest sourced visitor, the NPs with the greatest predicted visitor numbers derived from the model-averaged GLM, and the NPs with the highest and lowest residual values, calculated by subtracting the predicted antilogarithm visitor numbers from the actual antilogarithm visitor numbers. The R^2 for the model-average was 0.5950, indicating strong correlation between observed and predicted visitor numbers (Fig. 2.6; Cohen, 1988).

TABLE 2.10: The top ten ranking African NPs based upon the observed visitor numbers (n=69), the predicted visitor numbers, and the highest and lowest residual visitor numbers. The predicted values for all NPs for which complete trait data were available were estimated by the model-averaged GLM (n=233). For sites for which annual visitor numbers had been sourced, the predicted antilogarithm values were subtracted from the observed antilogarithm values to calculate residual values (n=69). All visitation data are given in antilogarithm form. For each NP, the host country and World Database on Protected Areas area ID code are given.

Rank	**NPs with the highest observed visitation**	**Observed visitation (1000s)**	**NPs with the highest predicted visitation**	**Predicted visitation (1000s)**	**NPs with the largest negative residuals**	**Residuals (1000s)**	**NPs with the largest positive residuals**	**Residuals (1000s)**
1	Kruger National Park South Africa 873	1892	Kruger National Park South Africa 873	1783	Tsavo West Kenya 19564	-108	Garden Route National Park South Africa 881	383
2	Garden Route National Park South Africa 881	491	Chobe Botswana 600	262	Marakele National Park South Africa 116257	-59	Mosi-Oa-Tunya Zambia 2347	288
3	Mosi-Oa-Tunya Zambia 2347	300	Tsavo West Kenya 19564	195	Mapungubwe National Park South Africa 308687	-42	Lake Nakuru Kenya 762	120
4	Chobe Botswana 600	296	Garden Route National Park South Africa 881	108	Kilimanjaro National Park Tanzania 922	-40	Serengeti National Park Tanzania 916	112
5	Lake Nakuru Kenya 762	163	Table Mountain National Park South Africa 300408	106	Meru Kenya 755	-20	Kruger National Park South Africa 873	109
6	Tsavo East Kenya 752	157	Nxai Pan Botswana 601	87	Tankwa-Karoo National Park South Africa 32816	-19	Tsavo East Kenya 752	94
7	Serengeti National Park Tanzania 916	148	Marakele National Park South Africa 116257	85	Agulhas National Park South Africa 301881	-15	Hell's Gate Kenya 7506	74
8	Amboseli Kenya 758	109	Mapungubwe National Park South Africa 308687	83	Udzungwa Mountains National Park Tanzania 19297	-10	Nairobi Kenya 761	71
9	Nairobi Kenya 761	97	Virunga Democratic Republic of Congo 166889	74	Mt. Elgon Kenya 760	-9	Amboseli Kenya 758	70
10	Tsavo West Kenya 19564	87	Etosha Namibia 884	74	Mikumi National Park Tanzania 919	-8	Lake Manyara Tanzania 924	51

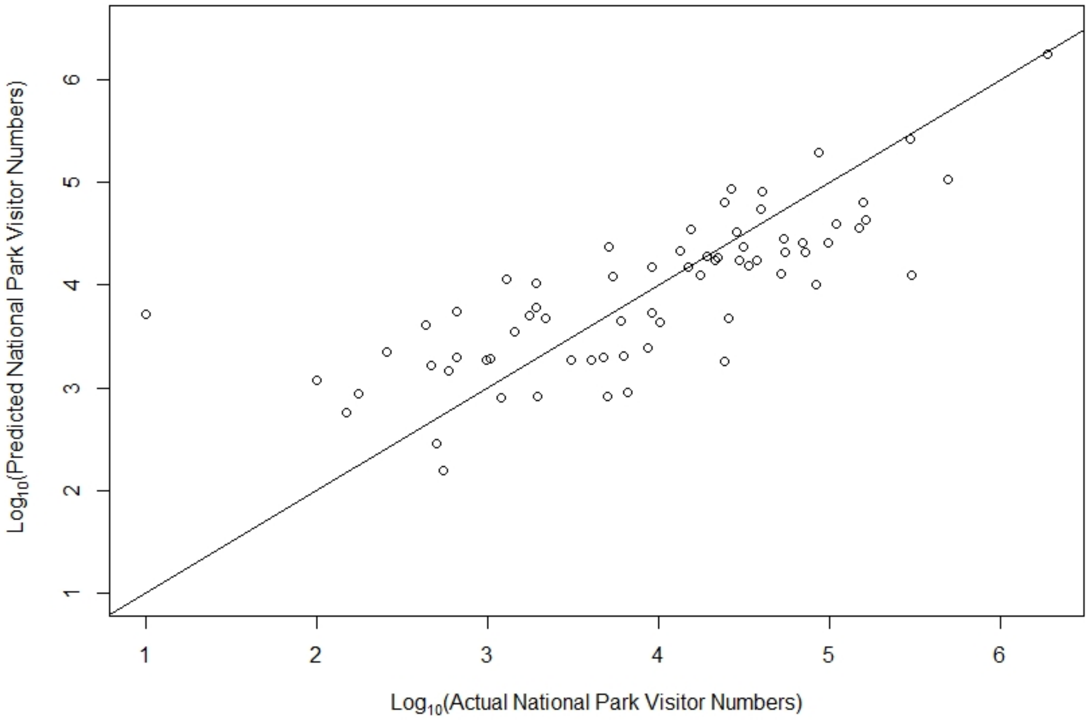

FIGURE 2.6: The relationship between the observed log_{10} visitor numbers to African NPs, and the predicted log_{10} visitor numbers based upon the model-averaged GLM. Only sites for which actual visitor numbers were sourced are shown (n=69). Reference (Y=X) line shown.

2.4 Discussion

The results of this study provide insight into the characteristics of species which determine their tourism attractor potential, relating to the number of WBT resources such species are mentioned in. The popularity of African birds tended to be driven by body mass, range size, migratory tendancy, extinction risk, evolutionary distinctiveness, habitat association, colour, and the presence of unusual appendages. The popularity of African mammals tended to be driven by body mass, range size, sociality, habitat association, pelage patterning and the presence of unusual appendages and adornments. The results of this study also provide insight into the characteristics of African NPs which determine their appeal to NB tourists. Visitor numbers to African NPs tended to be driven by the hosts country's level of human development, accessibility, habitat diversity, site age and wildlife popularity. From this, species which could be used to raise awareness of greater biodiversity have been identified, along with sites and communities within Africa which, with help from marketing strategies explored in Chapter 5, could develop more sustainable levels of tourism.

2.4.1 Traits Related to Species Popularity

The use of tourism resources to define species popularity, or tourism attractor potential, is a relatively new approach. The traits found to influence species popularity here are similar to those found through choice experimentation and contingent valuation methodologies. This provides further evidence that guidebooks and reports can be used as an alternative method of valuing a wide range of species in an efficient manner. Previous findings have identified biases in the conservation and research industries towards some species (Bakker et al., 2010; Metrick and Weitzman, 1996; Woods, 2000), specifically charismatic megafauna (Di Minin et al., 2013; Goodwin and Leader-Williams, 2000; Lindsey et al., 2007). The results of this chapter show that tourist's interests and preferences are not limited to such species, and that there is an appreciation for wider biodiversity and less charismatic species (Buckley, 2013; Di Minin et al., 2013; Hausmann et al., 2017a; Hausmann et al., 2017b; Lindsey et al., 2007).

Body mass was found to have the greatest influence on species popularity, or tourism attractor potential, a finding supported by previous studies (Arbieu et al., 2018; Bitgood, Patterson, and Benefield, 1986; Di Minin et al., 2013; Frynta et al., 2010a; Grünewald, Schleuning, and Böhning-Gaese, 2016; Kellert, 1996; Lindsey et al., 2007; Maciejewski and Kerley, 2014a; Maciejewski and Kerley, 2014b; Reynolds and Braithwaite, 2001; Stokes, 2007; Ward et al., 1998). This finding suggests that large-bodied species, such as the grey crowned-crane, *Balearica reufescens* and black-crowned crane, *Balearica pavonina* could be conserved and marketed to gain interest from the WBT industry. Body mass has been identified as a contributor to species charisma such that larger bodied animals are physically appealing and therefore are aesthetically charismatic, and are also usually more conspicuous, therefore are ecologically charismatic (Clucas, McHugh, and Caro, 2008; Lorimer, 2007; Reynolds and Braithwaite, 2001; Veríssimo et al., 2017). Ecological charisma, or viewing ease related to body mass (Lorimer, 2007), is particularly important with regards to tourism in African NPs, where wildlife-watching is typically carried out from a vehicle, rather than on foot.

As discussed in Chapter 1, marketing of charismatic flagship species by tourist companies, conservation organisations, researchers and filmmakers fuels the popularity of large-bodied charismatic megafauna within the tourism industry (Clucas, McHugh, and Caro, 2008; Di Minin et al., 2013; Entwistle, 2000; Garnett, Ainsworth, and Zander, 2018; Leader-Williams and Dublin, 2000; Macdonald et al., 2015; Okello, Manka, and D'Amour, 2008; Skibins, Dunstan, and Pahlow, 2017; Smith et al., 2012). In particular, the conservation and promotion of the "Big Five" group is known to attract many tourists to Africa (Lindsey et al., 2007). This group was mentioned across ten WBT resources, and all but the black rhinoceros, *Diceros bicornis*, were mentioned in at least 25 resources. The African savannah elephant, *Loxodonta africana* and African buffalo, *Syncerus caffer*, also appeared in the top ten for the highest predicted popularity. Conserving and promoting large-bodied megafauna has previously been associated with conflict with local communities over crop-raiding and livestock predation (Lindsey et al., 2007; Vollrath and

Douglas-Hamilton, 2002), as well as a general disregard for, and under-funding of, wider biodiversity (Goodwin and Leader-Williams, 2000; Kerley, Geach, and Vial, 2003; Lindsey et al., 2007; Maciejewski and Kerley, 2014a; Maciejewski and Kerley, 2014b; Smith et al., 2012). This suggests that improving public awareness of less charismatic species through WBT resources may enhance the appreciation tourists have for wider biodiversity, and therefore divert tourist pressure away from heavily utilised sites where charismatic megafauna are present (Thirgood et al., 2006).

Range size was also found to be an important driver of the popularity of species across the WBT resources. Contrary to previous findings, this chapter suggests that wide-ranging and common species, such as the common ostrich, *Struthio camelus*, and common eland, *Tragellaphus oryx* are more popular than range-restricted species, such as the eastern gorilla, *Gorilla beringei* (Steven et al., 2017; Veríssimo et al., 2009; Williams, Burgess, and Rahbek, 2000). Many tourists may not necessarily be interested in specific species, but simply wish to tick off or list as many species and attractions as possible whilst on a trip (Bulbeck, 2005; Desmond, 1999; Lemelin, 2006; Rasmussen, 1964). Thus, this accomplishment can be achieved easier and quicker when more common species are sought-after (Lemelin, 2006), for example, the "Safari 8" (Skibins, Powell, and Hallo, 2016). Conserving and promoting "Umbrella" species (Barua, 2011) with large ranges across Africa would not only benefit multiple PAs which rely on tourism revenue, but also help conserve many other co-occurring species which reside within these areas.

The findings associated with range size, however, may be an artefact associated with the methodology utilised. Firstly, widespread species, which can be observed in multiple sites across Africa are more likely to be mentioned by the tourism resources, therefore potentially over-predicting the effect of range size on species tourism attractor potential. Secondly, this chapter focused on mainland Africa, therefore many highly popular range-restricted island endemic African species were excluded from the analyses, e.g. the lemurs of Madagascar and the São Tomé fiscal, *Lanius newtoni*, potentially over-predicting the effect of range size on species popularity. If such species were considered in future study, then the understanding of range size on species popularity would be much improved. Thirdly, the BirdLife and IUCN species distribution polygons used to calculate range size across mainland Africa represent the complete extent of occurrence of a species rather than actual presence (Somveille et al., 2013; Willemen et al., 2015). Therefore incorporating species occupancy in relation to habitat type and elevation would also provide more accurate figures for range size (Somveille et al., 2013; Willemen et al., 2015). Additionally, the African forest elephant, *Loxodonta cyclotis* was predicted to be more popular than the African elephant which may reflect an inaccurate range size imputed for the former by Kirkland (2020). This imputed range size may have reduced the effect of range size on species popularity as the African forest elephant was only mentioned in four WBT resources.

Migratory tendancy was found to influence bird popularity. Species present in Africa all year round were found to be more popular than altitudinal and nomadic migrants, which in turn were more popular than full migrants. Non-migrants are present in NPs throughout the year, allowing tourist observations to persist, and therefore are more likely to be mentioned across the WBT resources. This finding is not supported by current PhD student, Kirkland (2020) global study which predicts that full migrants are the most popular birds. This may be due to the specific resources used to calculate species popularity. Many of the book resources were published in Europe and many of the brochures and websites are also managed from outside Africa. Therefore, the resources may reflect the European tourist preferences. Many African species considered in this study, in particular birds, can also be observed across Europe, and therefore may not be responsible for attracting European tourists to Africa. For example, species which were mentioned across fewer resources than predicted, relative to their traits, such as the rose-ringed parakeet, *Psittacula krameri*, black-tailed godwit, *Limosa limosa*, and wild boar, *Sus scrofa*, can be found in Europe, therefore the model predictions may have overestimated their potential to attract tourists which are targeted by these European-based resources. To gain greater resolution on the potential importance of migratory behaviour, as well as endemicity, it could be informative to consider the proportion of a species global range which occurs in Africa.

Sociality was found to influence mammal popularity, with group-living species such as the African buffalo being more popular than solitary species, such as the common genet, *Genetta genetta* supporting previous findings (Di Minin et al., 2013; Frynta et al., 2010a; Okello, Manka, and D'Amour, 2008). The formation of groups of individuals enhances the ability for tourists to experience fascinating behaviours and rituals, such as mating, play, pack-hunting and anti-predation (Clucas, McHugh, and Caro, 2008; Czajkowski et al., 2014; Dolata, 2006; Okello, Manka, and D'Amour, 2008; Reynolds and Braithwaite, 2001), which is further associated with aesthetic charisma (Lorimer, 2007). Group-living mammals are also typically easier to track and view, especially from a vehicle within a NP. Not only does sociality directly influence species appeal to tourists, but the presence of other species. For example, species predating on aggregations, and the thrill of watching a natural hunt, can cause an indirect influence on species popularity (Creel and Creel, 2002; Di Minin et al., 2013; Grünewald, Schleuning, and Böhning-Gaese, 2016; Lindsey et al., 2007). The "Great Migration", for example, attracts tourists both to NPs and television screens, as predictable superabundant species and their associated predators make an incredible journey across Kenya and Tanzania, reflecting the appeal of for example the plains zebra, *Equus quagga* (Okello, Manka, and D'Amour, 2008; Reynolds and Braithwaite, 2001).

Extinction risk was found to have a significant influence on the utilisation of birds as tourism attractors by the WBT resources. This was not the case for mammals. The finding associated with bird species is supported by previous studies which suggest that rare, threatened and endangered bird species are particularly popular (Arponen et al., 2005; Angulo and Courchamp, 2009; Bonn, Rodrigues, and Gaston, 2002; Booth et al., 2011; Di Minin et al., 2013; Kim et al., 2010; Reynolds and Braithwaite, 2001; Siikamäki et al., 2015; Veríssimo et al., 2009). This may reflect the greater guarantee of observing less threatened birds elsewhere, thus tourists may be less intrigued by such species. The absent effect of extinction risk on mammal popularity suggests that alternative factors have greater importance in determining tourism appeal of mammals. This is supported by previous research which suggests that extinction risk does not have an effect on the amount donated through zoo conservation "adoption" programmes, or the selection of species for such programmes (Colléony et al., 2017), which suggests that conservation effort is not being directed towards the most "at risk" species. The differences in effect of extinction risk on bird and mammal popularity may be reflected by preferences of tourists from along the LSC, where specialists and domestic tourists tend to be most interested in threatened bird species (Hausmann et al., 2017a), whereas more generalist and international tourists are typically interested in viewing common, low-risk mammals (Di Minin et al., 2013), or are simply not educated about conservation status (Sitas, Baillie, and Isaac, 2009). Furthermore, birds with higher degrees of evolutionary distinctiveness were found to be more popular than those which are less unique. This is supported by previous research which has shown that wildlife-based (WB) tourists value behavioural and ecological uniqueness in birds (Veríssimo et al., 2009).

Species habitat associations were also found to influence the popularity of species throughout the WBT resources. Species associated with habitats which provide good viewing ability while shielding the observer's approach are thought to be the most appealing (Reynolds and Braithwaite, 2001). The appeal of mammals associated with open and mosaic habitats may reflect good visibility (Goodwin and Leader-Williams, 2000; Gray and Bond, 2013; Kerley, Geach, and Vial, 2003; Kiss, 2004; Peel, Davies, and Hurt, 2004). For example, the white rhinoceros, *Ceratotherium simum*, may have been predicted to be more popular than the black rhinoceros, *Diceros bicornis*, due to their habitat differences, with the former found in open habitats, therefore more visible to wildlife-watchers (Pienaar, 1994). The appeal of mammals associated with forest habitats may reflect the popularity of foraging primates, as animal motion is known to appeal to tourists (Reynolds and Braithwaite, 2001). Likewise, adventure tourists (Perera, Vlosky, and Wahala, 2012; Walker et al., 1998; Zurick, 1992) and wildlife-specialists may be interested in exploring densely forested habitats on foot, associated with active tourism (Hausmann et al., 2017b). Bird species associated with open habitats and forest habitats, however, were found to appeal less to tourists, which may reflect a lack of shielding of the observer, and lack of visibility of the target species, respectively. Birds associated with artificial habitats may be represented less often as tourism attractors due to the appeal of more natural landscape features to tourists (Goodwin and Leader-Williams, 2000; Lindsey et al., 2007; Packer, Ballantyne, and Hughes, 2014; Turpie and Joubert, 2001). The appeal of species associated with bare habitats may reflect the appeal of geological features such as salt pans. Likewise, the appeal of bird species associated with aquatic habitats may reflect the ability of tourists to observe behaviours such as feeding and nesting in these areas (Beerens, Trexler, and Catano, 2017; Gatto, Quintana, and Yorio, 2008). The varying appeal of different habitat types suggests that many habitat types could be conserved not only for tourism purposes, but also to encompass and protect large amounts of biodiversity.

Time partitioning and trophic level were not found to influence species popularity. It was expected that nocturnal species would be less popular for tourism than diurnal species as in many NPs, public game drives and wildlife viewing are restricted to the daylight hours. Nocturnal species, however, could be mentioned by the WBT resources as a marketing strategy to promote private night game drives within NPs. Similarly, the nocturnal behaviour of some species may enhance their appeal to tourists, for example, the common hippopotamus, *Hippopotamus amphibious*, is relatively difficult to observe during the day due to submersion in water (Estes, 1997; Okello, Manka, and D'Amour, 2008). The lack of effect of trophic level on species tourism appeal could be reflected by the similar popularity scores of carnivores, such as the leopard, *Panthera pardus* (Arbieu et al., 2018; Lindsey et al., 2007; Macdonald et al., 2015; Okello, Manka, and D'Amour, 2008), herbivores, such as the African elephant, *L. africana* (Di Minin et al., 2013; Goodwin and Leader-Williams, 2000; Kerley, Geach, and Vial, 2003; Lindsey et al., 2007; Maciejewski and Kerley, 2014a; Walpole and Leader-Williams, 2002), and omnivores, such as many primate species.

Physical appearance traits, such as colour and shape, are known to contribute to an animal's aesthetic charisma, therefore influences the popularity of such species (Barua et al., 2012; Di Minin et al., 2013; Frynta et al., 2010a; Frynta et al., 2011; Frynta et al., 2013; Knight, 2007; Lorimer, 2006; Lorimer, 2007; Macdonald et al., 2015; Small, 2012; Stokes, 2007; Veríssimo et al., 2009; Veríssimo et al., 2014; Veríssimo et al., 2017), and even the amount people are willing to pay to conserve such species (Colléony et al., 2017). For birds, the Bright Colour Index and colour richness were found to be slightly positively correlated with species popularity within the WBT resources, but not significantly. This may indicate that species with bright and iridescent plumage colouration may appeal more to tourists than plainly coloured species. Such species may be more physically appealing than dull species, and iridescent colouration, in particular, contributes to conspicuousness (Barua et al., 2012; Stokes, 2007). For mammals, colour richness was not retained by the modelling framework, suggesting that it does not influence a species popularity. This reflects the non-universal association of human preference for colour (Stokes, 2007). This may, however, also be an artefact of the method derived to extract species physical appearance traits where, for example, four shades of brown were considered, yet there was only one category for the colour grey. The influence of colour richness on species popularity therefore may have been overlooked.

Four of the top ten performing mammal species: the leopard, African wild dog, *Lycaon pictus*, cheetah, *Acinonyx jubatus*, and giraffe, *Giraffa camelopardalis*, have prominent, notable pelage patterning, yet the influence of this attribute on mammal popularity was not found to be significant, and further had no effect on bird popularity, showing that other factors have greater importance when explaining the observed species popularity.

The presence of unusual appendages had opposing effects on bird and mammal popularity. Appendages such as large eyes, long legs, and long tails, were found to have a positive influence on bird popularity, but a negative influence on mammal popularity (the latter also not being significant). The popularity of bird species with unusually large or long appendages may reflect the appeal of "weird-looking" species (Veríssimo et al., 2017), or those which are distinctively morphologically different to humans (Woods, 2000), for example, the secretary bird, *Sagittarius serpentarius*, and Pel's fishing-owl, *Scotopelia peli*. The popularity of mammal species with for example, short extremities, may reflect the appeal of "baby schema" (Lorenz, 1943), and the ability for tourists to anthropomorphise such species, which has previously been associated with attractiveness (Jones, 2000; Lorimer, 2007; Root-Bernstein et al., 2013; Woods, 2000). Similarly, the presence of unusual adornments was assumed to increase species tourism appeal, however it reduced mammal popularity (though not significantly) and had no effect on bird popularity, suggesting that the previous significant variables play a greater role in influencing the number of WBT resources species are mentioned in. A choice modelling approach could be adopted to quantify the physical attractiveness of species more efficiently (e.g. Frynta et al., 2010a; Frynta et al., 2011; Lišková and Frynta, 2013; Macdonald et al., 2015; Veríssimo et al., 2017). Such an approach could provide insight into the effect of actual colouration, rather than colour richness, on tourism attractor potential. For example, previous research has found that specific colours (e.g. blue and yellow, Frynta et al., 2010a; Lišková and Frynta, 2013) influence the attractiveness of bird species.

2.4.2 Under- and Over-represented Species, Limitations and Recommendations

By determining the characteristics of species which influence their popularity within the WBT resources, birds and mammals which are currently under- and over-represented by the resources have been identified. Overlooked and highly performing species, such as the black crowned-crane, *Balaerica pavonina*, and red hartebeest, *Alcelaphus caama*, could act as potential flagship species and could benefit from increased marketing and public awareness, enhancing and broadening the public's appreciation for, and valuation of, wider biodiversity (Ballouard et al., 2012; Garnett, Ainsworth, and Zander, 2018; Goodwin and Leader-Williams, 2000; Kerley, Geach, and Vial, 2003; Lindsey et al., 2007; Randler, Hummel, and Prokop, 2012; Røskaft et al., 2003; Smith et al., 2012; Verissimo, MacMillan, and Smith, 2011). This could reduce visitor pressure on the current selection of highly marketed, well-known tourism attractors, such as the "Big Five" and their corresponding locations (Okello, Manka, and D'Amour, 2008).

The appeal of species to tourists, however, is not only influenced by the traits contemplated in this chapter, as shown by the amount of variance explained by the models. Additional factors which are hard to quantify but are known to influence tourism appeal are outlined here and could be considered by any future analyses.

A prime example of how additional factors can influence the tourism potential of a species is that of the reputation of the spotted hyena, *Crocuta crocuta* (Roque De Pinho et al., 2014; Macdonald et al., 2015; Okello, Manka, and D'Amour, 2008). An outline of the origin and development of the universally bad reputation of the spotted hyena is given here (see Glickman, 1995 for further detail). First, in Aristotle's *History of Animals and Generation of Animals*, there are references to pseudo-hermaphroditism, ugliness, scavenging, threatening behaviours, cowardice and deceit (Glickman, 1995), all psychologically negative descriptors. In the Middle Ages, spotted hyenas were generally portrayed in illustrations as evil beings, scavenging on human corpses (Glickman, 1995). Moreover, the natural historian Sir Walter Raleigh considered hyenas as the product of foxes and wolves, and therefore disregarded their preservation with relation to the Noah's Ark Concept (Glickman, 1995). More recently, the famed *Lion King* films have significantly contributed to the negative perception that western people have of spotted hyenas due to the creation of evil, voracious, scary characters (Beeton, 2006; Glickman, 1995), which will persist into the future due to the direction of the films towards young children, and therefore influencing corporeal charisma (Chawla, 2007; Colléony et al., 2017; Lorimer, 2007; Woods, 2000). Moreover, unlike the charismatic elephant and rhinoceros species, there are no "Save The Hyenas" organisations and *ex situ* conservation of hyenas is seldom exhibited (Glickman, 1995). The construction of negativity surrounding hyenas and their future has been described as a "serious miscarriage of biological justice" (Glickman, 1995). Therefore, educating the public on inaccurate information and misconceptions could reduce the negative attribute towards species which are rarely used as tourism attractors (Woods, 2000).

The top ten under-represented species with greater predicted popularity than observed popularity, relative to their traits and as defined by their negative residual scores, may possess traits, undefined by this study, which tourists may find unappealing. For example, species viewed as "ugly" are usually poor tourist attractors (Roque De Pinho et al., 2014; Glickman, 1995; Kellert, 1989; Knight, 2007), potentially reflecting an overestimation of the predicted popularity of the wild boar, Egyptian vulture, *Neophron percnopterus*, and Rüppell's vulture, *Gpys rueppelli*. Akin to hyenas, vultures generally have a bad reputation as scavengers and disease vectors, which could be considered by analysing trophic level in more depth. Similarly, the hadada ibis, *Bostrychia hagedash*, is common in urban areas of Africa (Singh and Downs, 2016), therefore may be less likely to draw tourists to NPs than species not commonly found in urban areas.

The inherent dominionistic characteristic of humans (Kellert, 1989) may be reflected in the poor representation of species with similar physical appearances to domestic animals within the resources. For example, the giant eland, *Taurotragus derbianus*, wild boar, and Nile lechwe, *Kobus megaceros*, may have poor tourism potential in reality due to their resemblance with domestic cattle, pigs, and feral goats, respectively (Woods, 2000). Bongos, *Tragelephus eurycerus*, may also have lower observed popularity than predicted as they physically resemble the more common nyala and kudu species and have restricted ranges within Kenya and western Africa where tourism may be limited. Tourism opportunities may also be limited in the Sahel, due to climatic and socio-economic factors, potentially reflecting the negative residuals of species restricted to this area such as the fox kestrel, *Falco alopex*, and red-fronted gazelle, *Eudorcas rufifrons*.

Akin to the above, species with greater observed popularity than predicted may possess appealing features which are undefined by this study. Many species identified by their positive residual scores as over-represented by the WBT resources in this study are familiar to the general public, due to publicity and promotion (Frynta et al., 2013; Martín-López, Montes, and Benayas, 2007). For example, some species may be marketed as flagship species by Non-Governmental Organisations, on commercial products (Macdonald et al., 2015; Smith et al., 2012; Veríssimo et al., 2017), or have broad presence across social media and fiction (Crawshaw and Urry, 1997; Di Minin et al., 2013; Macdonald et al., 2015). As mentioned, charisma influences a species flagship potential (Jones, 2000; Lorimer, 2007; Macdonald et al., 2015; Smith, Macmillan, and Veríssimo, 2010), and portrayal as a flagship enhances its appeal to the public (Garnett, Ainsworth, and Zander, 2018). This study, however, did not quantify charisma and only referenced ecological, aesthetic and corporeal attributes of charisma. The cheetah, for example, may have been represented by more resources than predicted, relative to its attributes, partially due to the public's familiarity with its record ground speed. Likewise, the positive residual of the meerkat, *Suricata suricatta*, may reflect the public's familiarity with its popular presence in wildlife documentaries and television programmes, such as Meerkat Manor and the Lion King.

Species which perform interesting behaviours, such as the alarm-calling of meerkats (Lorimer, 2007; Townsend et al., 2012), or the hunting antics of the African wild dog, Pel's fishing-owl, *Scotopelia peli*, the African fish-eagle, *Haliaeetus vocifer*, and the martial eagle, *Polemaetus bellicosus*, may appeal to tourists more than expected by the models. Similarly, primate species which have been classified as over-represented by the wildlife resources relative to their features, such as the Eastern gorilla, blue monkey, *Cercopithecus mitis*, chimpanzee, *Pan troglodytes*, guereza, *Colobus guereza*, L'hoest's monkey, may be more appealing to tourists than suggested due to their human-like behaviours. Deep, emotional attachments are suggested to form between humans and non-human primates due to their shared cultural and evolutionary histories, relating to corporeal charisma and the Similarity Principle (DeKay and McClelland, 1996; Gunnthorsdottir, 2001; Kellert, 1986; Kellert, 1989; Lorimer, 2007; Plous, 2010; Samples, Dixon, and Gowen, 1986). Therefore, it is suggested that evolutionary relatedness to humans could be explored. Likewise, species similar to domesticated animals, for example, "big cats", may be more popular for tourists than expected by the models as many tourists believe that they can interpret and understand the animals' behaviours more easily (Kellert, 1996; Shackley, 1996; Tremblay, 2002; Woods, 2000).

As previously explained, the physical appearance traits considered in this study may have not captured the true physical appeal of species. For example, the southern carmine bee-eater, *Merops nubicoides*, and black bee-eater, *Merops gularis*, are known to be particularly striking, and therefore their tourism potential may have been underestimated by the models. Additional socially constructed features such as "cuddliness" and "cuteness" could further be quantified and considered due to their suggested effect on tourism potential (Barua, 2011, Fischer et al., 2011; Lorenz, 1971; Lorimer, 2007; Woods, 2000). These features, for example, may have contributed to the over-represented status of the leopard, *P. pardus*, often ranked highly by similar studies (e.g.Di Minin et al., 2013; Grünewald, Schleuning, and Böhning-Gaese, 2016; Lindsey et al., 2007; Macdonald et al., 2015; Maciejewski and Kerley, 2014b). Similarly, the appeal of leopards could be related to attributes such as unpredictability and danger, which are known to entice tourists (Draper, 2006; Kellert, 1989; Norberg, 1999).

As also previously mentioned, endemicity and range restriction may manifest in the under-estimated appeal of some species by the modelling framework (Di Minin et al., 2013; Veríssimo et al., 2009). For example, all birds with the largest positive residuals are endemic to Africa. Likewise, the Ethiopian wolf, *Canis simensis*, is endemic to Ethiopia and the L'hoest's monkey, *Allochrocebus lhoesti*, and Eastern gorilla, are severely restricted to central Africa. These endemic or locally rare species may be perceived as more popular for tourists visiting the continent than cosmopolitan species as they cannot be observed elsewhere (Arbieu et al., 2018; Arponen et al., 2005; Di Minin et al., 2013; Goodwin and Leader-Williams, 2000; Grünewald, Schleuning, and Böhning-Gaese, 2016; Kerley, Geach, and Vial, 2003; Maciejewski and Kerley, 2014b; Okello, Manka, and D'Amour, 2008).

The methodology associated with utilising the WBT resources to determine species tourism potential also has its disadvantages. Firstly, all subspecies were recorded at the species level, which may have resulted in an incorrect calculation of some species observed popularity, and therefore, misrepresentation as over-represented by the resources, such as the blue monkey, *C. mitis*, and guereza, *C. guereza*. Secondly, the resources used to classify species popularity in this study were published from 1996 onward, therefore subspecies which have only recently been classified at the species level, such as the African forest elephant, Lichtenstein's hartebeest, *Alcelaphus lichtensteinii*, and the greyish eagle-owl, *Bubo cinerascens*, will have lower observed popularity than predicted by the modelling framework. The outdated WBT resources will also not reflect the changing preferences of tourists which develop with increased experience and public awareness (Bryan, 1977). Likewise, the current generation of tourists are thought to be shifting away from guidebooks and brochures, gaining greater influence from social media platforms when considering where to travel (Wood et al., 2013), which could be considered as a useful tool for gauging species appeal to tourists (Hausmann et al., 2017b; Willemen et al., 2015).

Ultimately, the use of tourism resources to estimate species tourism popularity is confounded by the author's perceptions of what tourists find attractive, which is further dependent on the target audience (Lorimer, 2006; Lorimer, 2007). Furthermore, the personal preferences the authors have for particular species will manifest in the popularity calculations. By consulting numerous sources, the bias associated with author preferences was thought to be reduced. Author preferences may be attributed to personal experiences with nature (Chawla, 2007; Di Minin et al., 2013; Giglio, Luiz, and Schiavetti, 2015; Hausmann et al., 2017a; Lindsey et al., 2007; Martín-López, Montes, and Benayas, 2007; Woods, 2000), attitude (Douglas and Veríssimo, 2014; Linnell, Swenson, and Andersen, 2000), knowledge (Martín-López, Montes, and Benayas, 2007; Randler, Hummel, and Prokop, 2012), corporeal charisma (Lorimer, 2007), phobias (Bjerke, Kaltenborn, and Thrane, 2001; Knight, 2007; Røskaft et al., 2003), age, wealth (Di Minin et al., 2013), culture (Ressurreição et al., 2012), religion (Bjerke, Kaltenborn, and Thrane, 2001; Dunham, 2006; Gosler et al., 2013; Richards, 2000), and photographic image quality and opportunities. Therefore, it is recommended that data regarding socio-demographics and preferences of authors could be sought, akin to studies involving the use of surveys to determine public preferences for species and their traits (e.g. Di Minin et al., 2013; Lindsey et al., 2007; Macdonald et al., 2015; Maciejewski and Kerley, 2014b).

2.4.3 Traits which Influence National Park Visitor Numbers

In accordance with previous findings, this study highlights the importance of HDI and habitat diversity in influencing tourism visitation (e.g. Hausmann2017sites). The results further sheds light on the importance of additional factors, notably wildlife popularity, in attracting visitors.

NPs located within countries with high indices of human development, such as South Africa, were found to attract the most tourists, supporting previous findings (e.g. Hausmann et al., 2017b). The HDI incorporates education, life expectancy and income metrics, the latter of which, with relation to Gross Domestic Product (GDP), has previously been found to influence tourism visitation also (Balmford et al., 2015; Ghermandi and Nunes, 2012). GDP and associated indices of development may drive, and in turn be driven by, the provision, quality and distribution of tourism infrastructure and amenities, such as in-country transport, which have previously been suggested as individual drivers of NBT (Arbieu et al., 2018; Beh and Bruyere, 2007; Foreign and Commonwealth Office, 2020; Goodwin and Leader-Williams, 2000; Grünewald, Schleuning, and Böhning-Gaese, 2016; Khadaroo and Seetanah, 2008; Lindsey et al., 2007; Neuvonen et al., 2010; Okello, Manka, and D'Amour, 2008; Sönmez, 1998; Turpie and Joubert, 2001). Countries with high HDI may also greatly invest in the tourism industry, and therefore support tourism operators, such as "Singita" and "And Beyond" which offer in-country transport and tour guiding packages which are known to attract tourists (Okello, Manka, and D'Amour, 2008).

Human Development Indices can further provide insight into a country's level of political stability, security and ability to recover from disease outbreaks (United Nations Development Programme, 2018), which have also previously been associated with tourism visitation (Akama and Kieti, 2003; Balmford et al., 2009; Goossens, 2000; Mansfeld and Pizam, 2006; Moran, 1994; Naidoo et al., 2016; Novelli, Morgan, and Nibigira, 2012). For example, multinational companies were found to invest into Kenya's tourism industry in the 1980s because it was perceived as a stable country in terms of socio-politics and economics (Akama and Kieti, 2003). Inter-ethnic political instability during the 1990s then led to a shift in visitor flow out of Kenya into Botswana, South Africa, Tanzania and Uganda; countries which could offer similar wildlife-viewing experiences under a greater sense of security (Akama and Kieti, 2003). At the extreme end of this scale, gorilla tourism within Volcanoes, Kahuzi-Biega and Virunga NPs in Rwanda and the Democratic Republic of Congo, was halted during the 1990s due to political stability and civil unrest (Alluri, 2009; Butynski and Kalina, 1998). More recently, in April 2020, unrest led to the death of park staff and destruction of equipment in Virunga (Virunga National Park, 2020).

Accessibility, defined by the travel time to the nearest city of 50,000 people, was found to have a negative effect on NP visitation. More remote sites, such as Richtersveld in South Africa, were found to receive fewer visitors than sites closer to cities, such as Table Mountain, though not significantly. Previous research also found that travel time and travel cost to major cities were significant factors in explaining the observed variance in visitor numbers (Balmford et al., 2015; De Vos et al., 2016; Hausmann et al., 2017b; Wilkie and Carpenter, 1999a; Willemen et al., 2015). The time and cost of travel may be related to airport distribution, transport infrastructure and road quality which may be associated with levels of HDI or GDP (Akama and Kieti, 2003; Grünewald, Schleuning, and Böhning-Gaese, 2016; Higginbottom, Tribe, and Booth, 2003; Khadaroo and Seetanah, 2008). More remote NPs may not have the facilities and amenities required for tourism visitation which are typically found in cities (Duffus and Dearden, 1990), likewise, remote NPs may be associated with higher levels of insecurity (Gössling, 2000; Moran, 1994). The effect of accessibility may not have been significant as many remote NPs also attract tourists which are less interested in facilities and prefer greater "sense of place" experiences (e.g. adventure-tourists, Zurick, 1992).

Unlike previous findings (e.g. Balmford et al., 2015; Ghermandi and Nunes, 2012; Hausmann et al., 2017b; Neuvonen et al., 2010), the size of the local population catchment surrounding NPs was not found to effect tourism visitation. This suggests that many tourists may be of international origin or travelling from larger cities on the continent (Di Minin et al., 2013). Similarly, many sites with densely populated surrounding areas may be influenced by higher rates of environmental degradation and conversion, poaching and other illegal activities, as well as biological edge effects, all of which could reduce the appeal of such areas to tourists (e.g. Tarangire and Mole NPs, Abukari and Mwalyosi, 2018; Woodroffe and Ginsberg, 1998).

Habitat diversity was also found to be a significant visitor attractant, with greater numbers of tourists being associated with greater numbers of habitat types. It is assumed that the greater number of habitat types, the greater the variation of viewable wildlife. The preference for savannah habitats, due to the associated viewing ease of large mammals, is well known (Akama and Kieti, 2003; Arbieu et al., 2018; Boshoff et al., 2007; Di Minin et al., 2013; Goodwin and Leader-Williams, 2000; Kellert, 1996; Kiss, 2004; Wilkie and Carpenter, 1999a), yet typically reflects the motivation of international, uneducated, first-time tourists (Hausmann et al., 2017a), who do not necessarily understand species-habitat associations (Skinner and Chimimba, 2005). Additionally, this study found preferences not just for large mammal species, therefore, alternative habitat types with less charismatic wildlife may appeal to tourists. Moreover, motivations differ for all people (Wood et al., 2013), and different habitat types offer different experiences which may appeal to adventure-tourists, or those interested in activities alternative to wildlife watching, such as hiking (Beedie and Hudson, 2003; Hausmann et al., 2017a; Hausmann et al., 2017b; Walker et al., 1998; Zurick, 1992). Additionally, natural, aesthetic landscape features, including geological formations (Fredrickson and Anderson, 1999; Fyhri, Jacobsen, and Tømmervik, 2009; Goodwin and Leader-Williams, 2000; Lindsey et al., 2007; Markwell, 2001; Packer, Ballantyne, and Hughes, 2014; Powell et al., 2012; Turpie and Joubert, 2001), and unique biomes, such as the fynbos in South Africa, are known to attract visitors, for example, to Garden Route and Table Mountain NPs (Hausmann et al., 2017a). NPs with low habitat diversity, such as Wadi El-Gemal - Hamata in Egypt, are thought to be the least appealing, potentially due to the associated low levels of biodiversity and lack of varying activities known to interest tourists (Hausmann et al., 2017a).

NP age was found to tourism visitation with older sites attracting more tourists than recently established sites, though not significantly. The positive effect of age on visitor numbers is supported by previous findings (Karanth and DeFries, 2011; Neuvonen et al., 2010). For example, Nairobi NP was the first NP established in Kenya, which could contribute to its position as a highly utilised site. The effect of age suggests that tourists are more aware or knowledgeable of older parks (Hanink and White, 1999; Mills and Westover, 1987), potentially due to the reputation developed by well-established NPs through media (Anson, 1999; Beeton, 2006), and visitor experience and satisfaction (Goodwin and Leader-Williams, 2000; Gössling, 1999; Grünewald, Schleuning, and Böhning-Gaese, 2016; Kerley, Geach, and Vial, 2003). The first sites designated as NPs are also typically the most spectacular and appealing with regards to wildlife and landscape (Neuvonen et al., 2010). Likewise, these sites have had greater time to develop more sophisticated, sustainable and attractive forms of service provision and facilities (Neuvonen et al., 2010), such as educational facilities (SANParks, 2006), accommodation (Balmford et al., 2015), road access (Hanink and White, 1999; Neuvonen et al., 2010), and air access (e.g. Kruger Mpumalanga International Airport, Ferreira and Harmse, 2014). The effect of age on tourism visitation may have not been significant as many recently established NPs may not have sophisticated management regulations in place, therefore allowing free-reign to visitors (Myers, 1972). For example, in 1985s, Kahuzi-Biega NP in the Democratic Republic of Congo placed limits on the number of tourists visiting gorillas, after first establishing gorilla-tourism in 1973 (von Richter, 1991).

Wildlife popularity was found to significantly influence tourism visitation to NPs, with sites hosting many popular species which are promoted by the WBT resources attracting the most tourists. Wildlife popularity was also found to strongly correlate with species richness, and sites with high species richness are thought to be most likely to succeed in the NBT industry (Siikamäki et al., 2015). It must be noted that more accurate species lists and therefore wildlife popularity values, could be sought for each NP by refining species range polygons to incorporate habitat preference and elevation (Somveille et al., 2013).

As discussed in the first part of this chapter, there is great diversity in the characteristics of what makes species appealing to tourists. Many generalist, international or uneducated tourists aim to see the "Big Five", large carnivores and mega-herbivores, whilst more specialist, experienced tourists aim to view rare or difficult to observe species. Therefore, NPs containing appealing species are more likely to attract tourists from multiple points along the LSC than sites with low species richness or species which possess unappealing features (Bryan, 1977; Buckley, 2013; Di Minin et al., 2013; Goodwin and Leader-Williams, 2000; Kerley, Geach, and Vial, 2003; Lindsey et al., 2007; Maciejewski and Kerley, 2014b; Okello, Manka, and D'Amour, 2008; Walpole and Leader-Williams, 2002; Winterbach, Whitesell, and Somers, 2015). The effect of wildlife popularity on tourism visitation was expected as WBT is thought to be a large component of the NBT industry within Africa. The findings support the idea that there should be greater investment into species conservation for tourism gain, and suggests that the loss of these popular species may reduce the WBT and NBT potential of a site. Biodiversity is increasingly recognised to be lost or conserved on a local scale, therefore the sustainable use of wildlife for tourism purposes is dependent on the relationships of conservation organisations, site managers and local communities (Pratt, Macmillan, and Gordon, 2004), as will be discussed in further detail in Chapter 5.

2.4.4 Under- and Over-utilised National Parks, Limitations and Recommendations

By determining which traits drive tourist visitation to NPs, currently under- and over-utilised sites have been identified. Underutilised sites or those which do not possess the most influential characteristics, could benefit from increased marketing, especially of features known to appeal to tourists. Consequently, this could generate positive socioeconomic benefits for stakeholders and local communities, reducing the dependencies on subsidies, whilst creating incentives to protect the natural world (Child, 1996; Goodwin and Leader-Williams, 2000; Grünewald, Schleuning, and Böhning-Gaese, 2016; Lindsey et al., 2007). Likewise, over-utilised sites could benefit from reduced marketing and strengthened management to reduce or divert visitor pressure (Armstrong and Kern, 2011; Lindsey et al., 2007; Okello, Manka, and D'Amour, 2008). These potential management implications are discussed in Chapter 5.

NP appeal, however, is not only defined by the traits considered in this study, as shown by the amount of variance in visitor numbers explained by the model average. There can be additional factors which influence tourist visitation, such as social media, familiarity, and alternative nearby tourist attractions (Bulbeck, 2005; Colléony et al., 2017; Wood et al., 2013), which could be considered in any future analyses. Here, with reference to the top ten over- and under-utilised sites, relative to their traits, other drivers of tourist visitation are examined.

The distribution and quality of facilities and services within NPs, including staff (e.g. Akama and Kieti, 2003), accommodation and cell-phone coverage, will influence tourism visitation, especially international tourists (Hausmann et al., 2017b). These factors could be inferred from levels of human development, accessibility and age of NP. For example, the observed visitor number of Udzungwa Mountains NP may have been lower than predicted by the modelling framework as there is no road network. Similarly, Tankwa-Karoo NP has no shops, fuel station or cell-phone coverage, Marakele NP and Mt Elgon NP have no lodge accommodation, Mapungubwe NP has no fuel station, ATM or cell-phone coverage, and there are no day-visitor facilities in Agulhas NP (SANParks, 2020; Kenya Wildlife Service, 2019).

Similarly, the presence of private lodges and concessions within or bordering NPs may attract additional tourism to the site (e.g. Kruger Scholtz, Kruger, and Saayman, 2013). Tour guides are also suggested to influence tourist satisfaction due to their knowledge of the park and the species within, therefore, sites with well-known tourism operators, private guides and educational facilities may attract more NB-tourists than predicted by this study (Grünewald, Schleuning, and Böhning-Gaese, 2016; Okello, Manka, and D'Amour, 2008; SANParks, 2006). Moreover, the price and perceived value of, for example, accommodation and entrance fees, will also influence tourism motivation and ultimately underpin levels of tourist satisfaction (Akama and Kieti, 2003).

Tourists will also have preferences for geographical and climatic factors. For example, the presence of aesthetic landscapes and viewpoints (Arbieu et al., 2018; Barendse et al., 2016; Beh and Bruyere, 2007; Goodwin and Leader-Williams, 2000; Grünewald, Schleuning, and Böhning-Gaese, 2016; Lindsey et al., 2007; Okello, Manka, and D'Amour, 2008; Packer, Ballantyne, and Hughes, 2014; Turpie and Joubert, 2001). By not considering aesthetic landscapes in this study, the predicted visitor numbers of some NPs may have been underestimated, and therefore contributed to them being considered as over-utilised in this study. For example, Mosi-Oa-Tunya, Amboseli and Hells' Gate NPs possess magnificent views of the Victoria Falls UNESCO World Heritage Site, Mount Kilimanjaro, and the Great Rift Valley, respectively. Similarly, tourists are known to have different tolerance levels for humidity, heat stress (Scott, Gössling, and Freitas, 2008; Verbos, Altschuler, and Brownlee, 2018), and site elevation (Hausmann et al., 2017b; Kumari, Behera, and Tewari, 2010).

Species abundance and evenness has previously been found to influence tourism visitation (Arbieu et al., 2018; Graves, Pearson, and Turner, 2017; Hausmann et al., 2017a; Hausmann et al., 2017b; Naidoo and Adamowicz, 2005; Naidoo et al., 2011; Reynolds and Braithwaite, 2001; Siikamäki et al., 2015). The wildlife popularity metric in this study, however, did not consider these factors as it was based upon species lists which represent binary data. Therefore, the observed visitor number of Amboseli NP may be higher than predicted by the modelling framework as people are known to be driven towards the regionally rare Maasai giraffe, waterbuck and common hippopotamus as well as the high densities of African savannah elephants (Grünewald, Schleuning, and Böhning-Gaese, 2016; Okello, Manka, and D'Amour, 2008). Similarly, many tourists are known to flock to the Amboseli and Serengeti NPs to view the "Great Migration" (Myers, 1972; Okello, Manka, and D'Amour, 2008). Moreover, the presence of water points, especially within dry areas, may attract tourists primarily to observe the congregations of wildlife and their interesting behaviours (Cao et al., 2016; Hopcraft, Sinclair, and Packer, 2005; Okello, Manka, and D'Amour, 2008; Smit, Grant, and Devereux, 2007; Wall-Reinius and Fredman, 2007). For example, the salt pans of Etosha NP (Arbieu et al., 2018), the swamps of Amboseli NP (Okello, Manka, and D'Amour, 2008), the Okavango delta and Savuti marshes of Chobe NP, and the algal lakes of Lake Nakuru NP and Lake Manyara NP facilitate wildlife-viewing of superabundant species. Thus, knowledge of species abundance may prove beneficial when outlining management implications for specific sites. Additionally, tourists may be interested in viewing additional taxa not considered by this study (e.g. reptiles).

The presence of additional tourist attractions within and nearby NPs, such as agriculture and food-related activities (Fleischer et al., 2018; Hjalager and Johansen, 2013), may also influence a tourist's decision on where to travel. Sites with additional attractions may have lower predicted visitor numbers than observed and may be incorrectly identified as over-utilised by tourists. The Nairobi Rhino Sanctuary and Sheldrick Wildlife Trust elephant orphanage which provide personal wildlife encounters may attract more tourists to Nairobi NP than predicted by the modelling framework (Davis et al., 1997; Orams, 1997; Orams, 2002; Schänzel and McIntosh, 2000). The presence of Tsavo East NP, Pilansberg NP, the Tuli Block and Selous Game Reserve World Heritage Site may dissuade tourists from visiting Tsavo West NP, Marakele NP, Mapungubwe NP and Mikumi NP, respectively. Maasai culture is known to attract tourists to Amboseli NP (Okello, Manka, and D'Amour, 2008). Similarly, many sites, for example Garden Route NP, Kruger NP and Kilimanjaro NP permit activities such as hiking and camping (Beedie and Hudson, 2003; Ferreira and Harmse, 2014 Hausmann et al., 2017a) which may appeal to adventure tourists or those less interested in wildlife-watching. Moreover, it can be recommended that the proportion of NP area which is marine could be considered as coastal landscapes and associated marine wildlife tourism may be an underlying contributor to site appeal.

Comparable to species popularity, there are many micro-scale influences on tourism visitation which are difficult to quantify (Kellert, 1996). In reality, the appeal of NPs will differ for each tourist due to expectations and motivations developed through interconnecting factors such as marketing (e.g. Kenya, Akama and Kieti, 2003), personal attitudes towards and beliefs about nature, sustainability and responsible tourism development (Blackstock et al., 2008; Curtin, 2005; Jackson, 1986; Schultz et al., 2004; Xu and Fox, 2014), culture (Macdonald et al., 2015; Xu and Fox, 2014), social media, television and reputation (Beeton, 2006; Crawshaw and Urry, 1997; Ferreira and Harmse, 2014). For example, the appeal of Kenya as a tourist destination may be generated by films (Beeton, 2006), such as Born Free, Out of Africa and The Lion King, and its demise in the 1990s associated with socio-political issues reinforced by the media (Akama and Kieti, 2003). It must be noted that social media, film and documentaries also create unrealistic expectations of close dramatic encounters with wildlife, which frequently leaves tourists dissatisfied and therefore less likely to visit again or recommend the destination to other tourists (Bulbeck, 2005; Curtin, 2005; Crawshaw and Urry, 1997).

Many tourists also wish to find a "sense of place" and belonging, a socially constructed sense of relaxation, enjoyment, identity and connection (Hausmann et al., 2016; Hausmann et al., 2017a; Lemelin, 2006; Millenium Ecosystem Assessment, 2005; Sharpley and Sundaram, 2005; Tuan, 1997; van den Berg, Koole, and Wulp, 2003). Such senses are constructed through fantasy, escapism, existential authenticity and self-dislocation from an increasingly urbanised world (Akama and Kieti, 2003; Beedie and Hudson, 2003; Curtin, 2005; Fredrickson and Anderson, 1999; Grünewald, Schleuning, and Böhning-Gaese, 2016; Lemelin, 2006; Markwell, 2001; Rojek and Urry, 1997). The desire to connect with nature is further influenced by previous experience and knowledge (Arbieu et al., 2018; Bryan, 1977; Curtin, 2005; Di Minin et al., 2013; Giglio, Luiz, and Schiavetti, 2015; Hausmann et al., 2017a; Lindsey et al., 2007; Russell et al., 2013) and socioeconomic demographics, such as age and wealth (Beedie and Hudson, 2003; Cousins, 2007; Curtin, 2005; Di Minin et al., 2013; Diamantis, 1999; Weiler and Richins, 1995). Ultimately, tourist expectations and levels of satisfaction will, in turn, drive management actions of NPs (Akama and Kieti, 2003; Eagles, 2014; Ferreira and Harmse, 2014). Little is known about the effect of sense of place and belonging on visitor numbers, yet it can be assumed that features such as viewpoints help to develop this connection (Hausmann et al., 2016), and overcrowding can act as a threat (Hausmann et al., 2017a). For example, the highway which bisects Mikumi NP may threaten this "sense of place" and therefore appeal less to tourists than expected by the modelling framework.

The visitor number data collated may have further confounded the results of this study. Some data included outdated information (e.g. those sourced from Balmford et al., 2015), and estimated for parks with open access, while further data may be costly (Hausmann et al., 2017b). For example, the observed mean annual visitor number for Digya NP in Ghana (10 visitors per annum sourced from Craigie, I., pers. comm. cited in Balmford et al., 2015) is thought to be inaccurate. It can be recommended that additional, more accurate visitor numbers could be sourced to help determine whether NPs in Africa are exceeding their visitor capacities and therefore require strengthened management, or are being underutilised, and could benefit from increased marketing and public awareness.

2.5 Conclusion

This study has identified the main drivers of species tourism potential using freely available data from the tourism resources. Such resources can be used as an alternative method to choice experimentation and contingent valuation methods to value a wide range of species in an efficient manner. The results have also provided insight into the drivers of tourism distribution across mainland African National Parks, using visitation data. Greater access to visitor number records could improve our understanding of what drives tourists to NPs. Future study should investigate how additional factors not considered in the analyses contribute to species and site appeal e.g. depiction in film and media. The results can be used to determine potential management implications for species which could benefit from increased promotion and public awareness, and for sites which may require influence from marketing techniques in order to redistribute tourism demand and subsequent pressure, as to be discussed in Chapter 5.

The next chapter considered the drivers of NBT across Great Britain, by following the same approach here.

Chapter 3

The Drivers of Nature-based Tourism Across Great Britain

3.1 Introduction

The growing concerns of climate change, declining biodiversity and animal welfare have led to an increased interest in the relationships between nature and society (Macmillan and Phillip, 2008). Such relationships include ecosystem services, for example production services such as food provisioning, and cultural services, such as nature-based tourism (NBT). Such services, united with less tractable values such as option, existence and bequest values, combine in what has been referred to as a Total Economic Value framework (TEV; Costanza et al., 1997; Tisdell and Wilson, 2003). This study focuses on understanding the drivers of NBT, and wildlife-based tourism (WBT); the latter a sub-sector of NBT more closely focused on viewing wildlife within a natural environment (Morrison, 1995). Increased urbanisation and isolation from nature is driving a demand for wildlife interactions and "sense of place" experiences (Beedie and Hudson, 2003; Curtin, 2005; Gössling, 2002; Urry, 1990; Wolch, West, and Gaines, 1995). This demand is further enhanced by increased accessibility to natural destinations and awareness of the psychological benefits of nature (Shackley, 1996).

3.1.1 Nature-based Tourism in Great Britain

Within Great Britain (GB), increases in environmental and economic awareness and the recognition of the negative impacts of international travel have contributed to the growth in domestic tourism in recent years (Hughes, 2001; VisitBritain, 2018). In 2018, 1.7 billion day trips were taken in GB with 3% and 7% of these visitors participating in wildlife watching and sightseeing on foot, respectively (GBDVS, 2018). Around 2.85 million adults participate in bird watching in the UK (BMRB International, 2004) with the Royal Society for the Protected of Birds (RSPB) boasting over 1.2 million members (RSPB, 2019). Nature-related activities commonly occur within protected areas (PAs) which permit and encourage tourists to gain close-up experiences with nature, whilst protecting the environment (Hughes, 2001). PAs within GB are managed by both governmental (e.g. Natural England (NE), Scottish Natural Heritage (SNH) and Natural Resources Wales (NRW)) and non-governmental organisations and charities (e.g. the National Trust (NT), RSPB), as well as being in private ownership (e.g. Knepp Estate).

Within GB, PAs and associated NBT can contribute significantly to local economies and surrounding areas by providing direct employment and volunteer opportunities, especially in remote locations with few employment alternatives; the latter typically associated with agriculture and forestry (Crabtree et al., 1994; Dickie, Hughes, and Esteban, 2006; Lennon and Harris, 2020; MacLellan, 1999; Rayment and Dickie, 2001; Rotherham, Doncaster, and Egan, 2005; Shiel, Rayment, and Burton, 2002). Spending by employees, volunteers and visitors also contributes to local economies, supporting additional jobs in areas such as transport and hospitality. For example, £11.8 million is estimated to be spent annually by RSPB reserve visitors, primarily on accommodation, food, and fuel (Dickie, Hughes, and Esteban, 2006; Shiel, Rayment, and Burton, 2002). Many PAs also support local communities through expenditure on commercial contractor services and providing leasehold land for grazing and agriculture (Shiel, Rayment, and Burton, 2002). For example, the RSPB supports 300 farmers in the UK through the letting out of 14,500 ha of land (Shiel, Rayment, and Burton, 2002). Moreover, products from reserve management, such as meat and timber, are sold to and processed by the local community, further supporting the local and national economies (Shiel, Rayment, and Burton, 2002). For example, the RSPBs sale of venison between 1996-7 and 2000-1 contributed £17,000 to local economies (Shiel, Rayment, and Burton, 2002).

Not only do PAs convey benefits to local communities, but they are also necessary to protect British wildlife from threats such as habitat loss and degradation from factors such as agricultural intensification and urban expansion (Battersby, 2005; Jackson and Gaston, 2008; Newton, 2004). Wildlife can further encourage NBT ventures, for example, tourism associated with the white-tailed eagle, *Haliaeetus albicilla*, population on the Isle of Mull generates £5 million annually (Molloy, Thomas, and Morling, 2011). Tourism spending can further be directed into species conservation and management. For example, the shooting industry, a form of consumptive NBT, contributes £250 million per year towards grouse moorland management (PACEC, 2014). Moreover, PAs are ideal locations for the introduction, and re-introduction, of native species, such as the European beaver, *Castor fiber*, (Gaywood et al., 2015), and natterjack toad, *Epidalea calamita* (e.g. Mersehead, Shiel, Rayment, and Burton, 2002).

Flora and fauna are not unaffected by the presence of tourists within PAs, as considered in Chapter 1. There have been many documented accounts of the direct (e.g. Chin et al., 2000; Higham, 1998; Mathieson and Wall, 1982), and indirect impacts (e.g. Orams, 2002) of tourism on both focal species and the wider environment. Concerns have also arisen over commercialisation and facility development as a result of the combination of increased tourism demand and poor visitor management (Duffus and Dearden, 1990;

Eagles, Mccool, and Haynes, 2002; Knight and Cole, 1995; La Page, 2010). Similarly, high levels of tourism can have negative socio-economic impacts on local communities (Beeton and Benfield, 2002; Blackstock et al., 2008), and on other visitors' experiences (e.g. overcrowding Davis et al., 1997; English Natinoal Parks Authorities Association, 2007). Thus, understanding what drives tourist behaviour is highly important for enhancing tourist management within PAs which facilitate NBT and WBT, without compromising the environment and its ecosystem services, or local community livelihoods.

3.1.2 Features Which Appeal to Tourists

The NBT market is heterogeneous, comprising tourists which fall along the *Leisure Specialisation Continuum* (Bryan, 1977), from more generalist to specialist individuals (Duffus and Dearden, 1990, see Chapter 1 for further detail). The motivations which drive individuals to participate in NBT differ drastically. Such motivations influence their level of involvement (Cole and Scott, 1999; Curtin, 2005) and the influence of nature on their personal behaviour (Mayes, Dyer, and Richins, 2004; Orams, 1997; Zeppel and Muloin, 2007).

Previous research has suggested that people are typically attracted to species that are: aesthetically appealing (Norberg, 1999; Tremblay, 2002), large (Kellert, 1989), diurnal, and tolerant of human encroachment (Reynolds and Braithwaite, 2001). As wildlife-watching is associated with non-use values, and such activities do not necessarily require payment, the underlying tourist preferences are typically derived through contingent valuation and choice experimentation (Macmillan and Phillip, 2008), as discussed in Chapter 1. One common method of valuing species and their characteristics is through "Willingness to Pay" surveys, which are limited in both space and time, and simply result in hypothetical values for a limited number of selected species (Macmillan and Phillip, 2008; Wood et al., 2013). These selected species are often the target of PA management, flagship marketing and fundraising campaigns, therefore typically exclude wider biodiversity (Goodwin and Leader-Williams, 2000; Wood et al., 2013).

Further, previous findings have shown that tourists are typically attracted to areas that are: unspoiled (Fredrickson and Anderson, 1999; Markwell, 2001), natural in habitat cover (Curtin and Wilkes, 2005), rich in flora and fauna, remote (Curtin, 2010), and large (Balmford et al., 2015). A recent study by Balmford et al., 2015 involved building a modelling framework to predict PA visitor numbers, based upon PA attributes. Modelling visitation can assist PA managers to identify the socio-economic and political use of PAs to advocate investment and attract external funding, as well as predict the effectiveness of marketing approaches on NBT participation (Armstrong and Kern, 2011; Phillips, 1998). Thus, understanding what drives tourism visitation is critical for the planning and sustainable management of NBT within PAs (Eagles, 2014).

3.1.3 Chapter Plan

This study, similar to Chapter 2, adopts an alternative method associated with WBT resources to identify what species and their characteristics appeal to tourists. Using visitor number data, PA features which attract tourists will then be identified.

WBT resources, in the form of guidebooks and brochures, are thought to reflect tourist preferences for destinations and associated wildlife (Eagles, Mccool, and Haynes, 2002; Kirkland, 2020; Newhouse, 2017; Reynolds and Braithwaite, 2001), with species of great attractiveness to tourists mentioned most frequently across the resources (Kirkland, 2020; Newhouse, 2017). Here, following Chapter 2, a modelling framework will be built to explore whether species popularity in WBT resources is determined by key features relating to species' visibility, threat and physical appearance. This chapter will also focus on birds and terrestrial mammals which are known tourism-attractors (Clucas, McHugh, and Caro, 2008; Dickie, Hughes, and Esteban, 2006; Lišková and Frynta, 2013; Schlegel and Rupf, 2010; Smith et al., 2012). From reviewing the literature, it is expected that the most popular species will be large-bodied, readily viewable, threatened, evolutionary distinct, group-living, diurnal and physically appealing.

Concurrently, the wildlife popularity of each PA will be estimated using a simplistic approach of intersecting PA polygons from the World Database on Protected Areas (WDPA) with a species popularity raster which utilises species occurrence data from online datasets (Gillings et al., 2019; National Biodiversity Network, 2020) and the species popularity scores from the first part of this chapter. Such freely available, geographically comprehensive datasets have previously been utilised to map species distributions (e.g. Wal et al., 2015) and examine changes in species population sizes (e.g. Chamberlain and Fuller, 2000), in relation to climate change (e.g. Thomas and Lennon, 1999). A separate modelling framework will evaluate the extent to which biogeographical and socioeconomic variables drive tourists to British PAs, utilising visitation data. From reviewing the literature, it is expected that the highest visitor numbers will be associated with well established, large, easily accessible PAs with popular flora and fauna. Consequently, the drivers of NBT across GB will be identified, and destinations which are currently over- and under-utilised by the tourism market, relative to their traits, will be identified. Management implications for such sites will be discussed in Chapter 5.

3.2 Methodology

3.2.1 Species Popularity

3.2.1.1 Trait Data Collection

A comprehensive list of 621 British bird species was extracted from the Checklist of the Birds of Britain (British Ornithologists' Union, 2018) and aligned with the avian taxonomies of BirdLife International (BirdLife International, 2017). A subset of 244 bird species which are regularly occurring across GB and classified by the "Red List for Birds"

(Eaton et al., 2015) was examined in this study, following former CEG MBiol project Sammut (2018).

A comprehensive list of 70 terrestrial mammal species found within the UK was then extracted from the UK Mammal List (The Mammal Society, 2019). A subset of 38 mammals was examined in this study. This subset excluded species of the order Chiroptera (bats) and the European mole, *Talpa europaea*, as these species groups are seldom seen (due to nocturnal and subterranean behaviour respectively), and therefore rarely attract WBT. Rat species were excluded from this subset as these species are widely regarded as vermin, therefore rarely attract tourism. Domesticated cattle and feral sheep were excluded due to the lack of physical trait data available for such species. Reindeer, *Rangifer tarandus*, though also classified as domesticated by the UK Mammal List (The Mammal Society, 2019) was retained within the dataset as they are known to attract many tourists to the Cairngorm NP and associated PAs (The Cairngorm Reindeer Herd, 2020). Raccoon, *Procyon lotor*, was excluded as this species is yet to establish a population within the UK. Northern Ireland, the Channel Islands and the Isles of Scilly which contribute little to the overall area considered were excluded from this study due to limits on data availability and comparability (e.g. Jackson and Gaston, 2008). Therefore, the greater, *Crocidura russula*, and lesser white-toothed shrew, *Crocidura suaveolens*, species found on the Channel Islands and Isles of Scilly, respectively, were not considered by the analyses.

For all species of interest, body mass, global extinction risk, evolutionary distinctiveness, habitat association, trophic level, time partitioning, sociality (for mammals only), coloniality and migration tendency (for birds only) data were extracted previously by the Conservation Ecology Group (CEG) at Durham University, following the methodology outlined in Chapter 2. Former MBiol student Sammut (2018) collated data on British mammal range size, calculated by the number of 10km grid cells in which each species occupied using data from Arnold (1993). Sammut (2018), also collated the national extinction risk of British bird species from the Birds of Conservation Concern dataset (BCC; Eaton et al., 2015), which categorises species' level of risk ranging on a continuous scale in this study from 'Red-List' (1), 'Amber-List' (2), to 'Green-List' (3). Many BCC datapoints collated by Sammut (2018) were not supported by the Eaton et al. (2015) source, therefore these data were extracted a second time as part of this project.

The following trait data, additional to those compiled previously, were collated as part of this project. Data describing the physical appearance of birds and mammals, including colour richness, Bright Colour Index for birds, and the presence of unusual appendages, adornments and distinct patterning, were extracted from species illustrations as outlined in Chapter 2. The British range size of bird species, which was the combined breeding and wintering range, were recorded as the number of 10km grid cells in which species had been detected, using occurrence data from bird atlases (Gillings et al., 2019). A log_{10}-transformation was applied to the range size of both bird and mammal species to reduce the leverage of a relatively small number of wide-ranging species in models. British range size data were not available for three bird species. Trait data, excluding range size and BCC status, were not available for two bird species.

3.2.1.2 Species Popularity Scoring

Following Chapter 2, site-specific mentions of birds and terrestrial mammals were extracted from five WBT resources and compiled with records extracted from three additional resources by former MBiol student, Sammut (2018) (Table 3.1). All resources, including those ostensibly related to other taxa, were comprehensive sources of information on both birds and terrestrial mammals. In total, 28,856 records of birds and 2,158 records of terrestrial mammals were extracted from the resources. Following the methodology of Chapter 2, the popularity of species was calculated as the total number of resources such species were mentioned in.

TABLE 3.1: List of the WBT resources from which site-specific species mentions were recorded.

WBT Resources Consulted
Hywel-Davies and Thom (1984), The Macmillan Guide to Britain's Nature Reserves. Macmillan London Ltd., UK.
Lowen (2016), A Summer of British Wildlife. Bradt Travel Guides Ltd., UK.
Ordanance Survey (1989), Nature Atlas of Great Britain, Ireland and the Channel Isles. Duncan Petersen Publishing Ltd., UK.
Regan (2009), Where to go wild in Britain, A month-by-month guide to the UK's best wildlife experiences. Dorling Kindersley Ltd., UK.
Walters and Gibbons (2003), Britain: Travellers' Nature Guide. Oxford University Press, USA.
Somerville (2013), Where to See Wildlife in Britain and Ireland. Harper Collins, UK.
Dudley, Dudley, and Mackay (2007), Watching British Dragonflies. Subuteo Natural History Books, UK.
Tipling (1996), Top Birding Spots in Britain and Ireland. Harper Collins Education, UK.

3.2.1.3 Statistical Analysis

Trait data were available for 239 bird species and all 38 terrestrial mammals species. Of these species, 237 birds and all 38 mammals were mentioned across the WBT resources. Following Chapter 2, analyses were conducted only on the species which were mentioned across the WBT resources (relevant data for these species can be found in Appendix A section A.2).

To explore the relationship between the number of resources in which species were mentioned and potential explanatory variables, generalized linear models (GLMs) were fitted to the data using a Poisson error structure using the R package 'lme4' (R Development Core Team, 2019). Model comparison using the AIC showed that the inclusion of phylogenetic order as a random effect within a GLMM did not improve the fit of both the bird and terrestrial mammal models. All covariates were centred and standardised. There was no evidence of collinearity between the explanatory variables.

The global GLM for exploring the popularity of bird species across WBT resources included extinction risk, body mass, evolutionary distinctiveness, trophic level, time partitioning, habitat association, coloniality, migratory strategy, colour richness, Bright Colour Index, distinct patterning, unusual appendages and unusual adornments. The global GLM for exploring the popularity of mammal species across the WBT resources included extinction risk, body mass, evolutionary distinctiveness, trophic level, time partitioning, habitat association, sociality, colour richness, distinct patterning, unusual appendages and unusual adornments.

The same model-selection and model-averaging framework from Chapter 2 was applied to the analyses in this chapter using R package 'MuMIn' (Barton, 2009). Due to the limited sample size for the terrestrial mammals, only model combinations with <4 degrees of freedom were considered in the model selection process to prevent overfitting. The full model-average of the top performing models were used to predict the popularity of bird and mammal species within the WBT resources. The predicted popularity scores were subtracted from the observed popularity scores to calculate residual scores. Species that might currently be overlooked as tourism attractors by the resources, relative to their traits, were identified by negative residual scores.

3.2.2 Tourism Within Protected Areas

3.2.2.1 Trait Data Collection

A comprehensive list of 10,812 completely or partially terrestrial IUCN categorised PAs with polygon outlines across GB was extracted from the WDPA (UNEP-WCMC and IUCN, 2019). A subset of 3,033 PAs was examined in this study. The subset excluded PAs from the Channel Islands and the Isles of Scilly as these areas were not considered by this study due to limits on data availability and comparability. This subset also excluded PAs with areas smaller than $1km^2$ as such areas are thought to not support intact communities of vertebrate species (Gurd, Nudds, and Rivard, 2001). British National Parks (NPs) and Areas of Outstanding Natural Beauty (AONB) were also excluded as such areas attract many visitors not visiting for NBT purposes, and are not designated exclusively on a conservation basis (Holdaway and Smart, 2001).

For each PA, data were compiled on site area, age (years since establishment), habitat diversity, primary habitat type, mean monthly temperature, accessibility, local population catchment size, governance type, and wildlife popularity, as detailed below. These selected traits reflect factors known (e.g. area, Balmford et al., 2015, e.g. temperature, Richardson and Loomis, 2004), or suspected (e.g. wildlife popularity) to influence tourist's decisions when choosing a NBT destination.

Site area was extracted from the WDPA (UNEP-WCMC and IUCN, 2019), and was log_{10}-transformed to reduce leverage of a relatively small number of large sites, following the methodology in Chapter 2. Habitat diversity, primary habitat type and accessibility (relating to travel time) were previously compiled by PhD student, Kirkland (2020), following the methodology outlined in Chapter 2. Accessibility was log_{10}-transformed to reduce leverage of a relatively small number of highly remote sites in the models. Kirkland (2020) also extracted data on mean monthly temperature from WorldClim (2016) (Beta version 1 dataset).

The following trait data were compiled as part of the current project. The human populations within a 10km buffer of each PA was calculated (as a proxy for the local potential visitor pool) using the 2011 UK gridded population based on Census 2011 (Reis et al., 2017) and the R packages 'dplyr', 'raster', 'rgdal', and 'rgeos' (R Development Core Team, 2019), and log_{10}-transformed to account for skew. The governance type of each PA was extracted from the WDPA (UNEP-WCMC and IUCN, 2019), and condensed into the four broad categories outlined by the IUCN Governance of PA guidelines (Borrini-Feyerabend et al., 2013, see Table A.3 in Appendix A). The designation type (e.g. National Nature Reserve, Local Nature Reserve) of each PA was also extracted from the WDPA (UNEP-WCMC and IUCN, 2019).

Due to computational intensity, estimated species lists could not be calculated using the polygon overlay method described in Chapter 2, therefore an alternative method was adopted to estimate the wildlife popularity of each PA in this chapter. PhD student Kirkland extracted the latest (2008-2011) breeding bird occurrence data at 10km resolution from Gillings et al. (2019) and recent (2008-2020) accepted mammal occurrence data within 10km resolution from the National Biodiversity Network (2020), and used the actual species popularity values from this chapter to create a raster of summed bird popularity and a raster of summed mammal popularity using R packages 'raster', 'sf', and 'dplyr' (R Development Core Team, 2019). The summed bird and mammal popularity rasters were intersected with PA polygons downloaded from the UNEP-WCMC and IUCN (2019), using R packages 'raster' and 'sf', to estimate the mean cumulative bird and mammal popularity of the 10km grid cells within each PA. There was only a weak correlation between mammal popularity and bird popularity (r_{229} = 0.2790, p<0.0001; Hinkle, Wiersma, and Jurs, 2003), therefore they were not combined into a single wildlife popularity metric.

3.2.2.2 Annual Visitor Numbers

Annual visitor numbers of GB PAs were collected from personal contacts within the managerial organisations of each site, as well as academic and grey literature, following the approach of Balmford et al. (2015) (data can be found in Appendix A section A.2). Mean annual visitor numbers were calculated for each site. For some PAs, visitor numbers had been collected from multiple sources. The mean annual visitor number for these sites were calculated from across the mean annual visitor number of each source. Some sourced visitor numbers represented only sections of PAs (e.g. Loch Leven visitor numbers were sourced for both the RSPB and SNH reserve sections), therefore, the mean annual visitor numbers from the two sources were summed to represent visitors to the entire PA.

3.2.2.3 Statistical Analysis

Complete trait data were available for 1,927 PAs (Table 3.2; data can be found in Appendix A section A.2). Analyses were conducted on the 213 PAs for which annual visitation data were sourced. Visitor numbers were log_{10}-transformed to account for skew. Following the methodology in Chapter 2, generalized linear models (GLMs) were fitted to explore the relationship between the visitor numbers and the various potential explanatory variables described above in R (R Development Core Team, 2019). All covariates were centred and standardised.

TABLE 3.2: The number of British PAs, within the subset considered in this study, for which trait data were available.

Trait	**Number of PAs with trait data available**
log_{10} area	3033
Age	3033
Habitat diversity	1929
Primary habitat type	1929
Mean monthly temperature	1929
log_{10} accessibility	2372
log_{10} local catchment population	2017
Governance type	3033
Designation type	3033
Bird popularity	2974
Mammal popularity	2974

There was evidence of collinearity between local catchment population and accessibility (r_{211} = -0.7790, p<0.0001), and governance type and designation type ($\chi^2_{8,213}$ = 213, p< 0.0001). Therefore, in order to determine which traits was the most important in predicting visitor numbers, four global models were fitted to consider the combinations of local catchment, accessibility, governance type and designation type (Table 3.3). Model comparison using the Akaike Information Criterion (AIC) and R^2 showed that local catchment population and governance category were more important in predicting visitor numbers than accessibility and designation type.

The global GLM for exploring the observed annual tourism visitation of PAs included area, age, habitat diversity, primary habitat type, local catchment population, governance type, bird popularity and mammal popularity, using Gaussian error structure.

The model-selection and model-averaging framework outlined in Chapter 2 was applied to the global GLM using R package 'MuMIn' (Barton, 2009). The full model-average was used to predict the annual visitor numbers of the 1,927 PAs for which complete trait data were available. Values could not be predicted for three PAs with governance

TABLE 3.3: The global GLMs for British PA visitor numbers which considered all four possible combinations of the correlated variables. (*) indicates the top performing global GLM which was consequently used in this chapter.

Model number	Variables in model	AIC	R^2
1*	Area + age + temperature + habitat diversity + primary habitat type + mammal popularity + bird popularity + local catchment population + governance type	516.8757	0.1319
2	Area + age + temperature + habitat diversity + primary habitat type + mammal popularity + bird popularity + local catchment population + designation type	521.1009	0.1310
3	Area + age + temperature + habitat diversity + primary habitat type + mammal popularity + bird popularity + accessibility + governance type	517.0292	0.1313
4	Area + age + temperature + habitat diversity + primary habitat type + mammal popularity + bird popularity + accessibility + designation type	521.2374	0.1304

type category D as no visitor numbers had been sourced for category D PAs. For the PAs for which visitor number data had been sourced, the predicted antilogarithm values were subtracted from the sourced antilogarithm values to calculate residual values. Sites which are currently over- or under-utilised by nature-based (NB) tourists, relative to their features, could be indicated by positive and negative residual values, respectively.

3.3 Results

3.3.1 Species Popularity

Table A.10 in Appendix A describes the results of the global GLM for bird popularity within the WBT resources. The model selection process yielded four top models including the null model, which best explained the popularity of bird species (Table 3.4). The top performing models included two of the 15 attributes.

TABLE 3.4: The top performing GLMs from the model selection process used to predict British bird popularity. All models with ΔAIC<6 were considered. Complex models with lower ΔAIC than simpler nested models were retained, following Richards (2008).

Model rank	Variables in model	AICc	ΔAIC	weight	df
1	Distinct patterning + trophic level	942.7241	0.0000	0.4730	4
2	Distinct patterning	943.5460	0.8219	0.3136	2
3	Trophic level	945.6397	2.9157	0.1101	3
4	NA	945.7648	3.0408	0.1034	1

The model-averaged GLM for bird species indicated that distinct patterning and trophic level were the only traits which influence the number of resources species were mentioned in, yet these effects were not found to be significant (Fig. 3.1, see Table A.11 in

Appendix A). Species with distinct patterning tended to be the most popular, and carnivorous species tended to be more popular than omnivorous and herbivorous species.

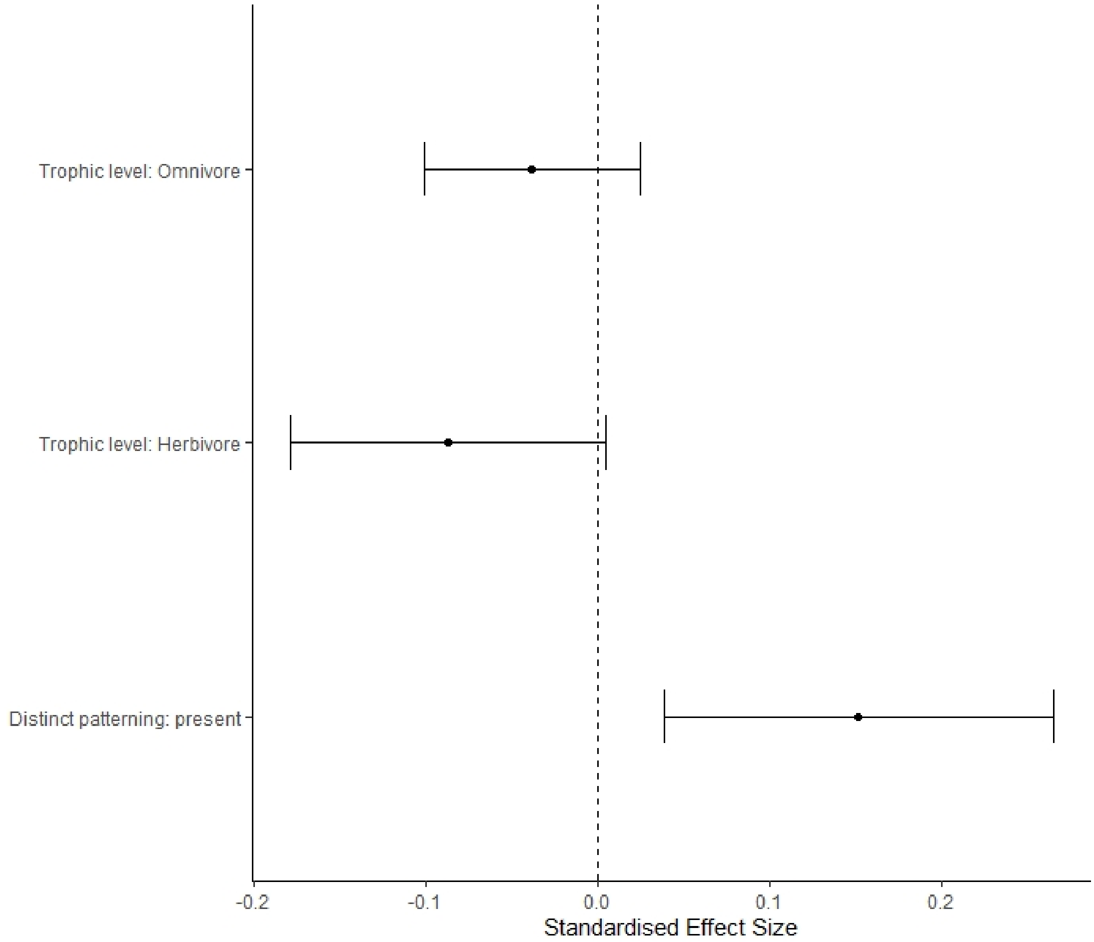

FIGURE 3.1: Standardised effect sizes of the model-averaged GLM coefficients for GB bird popularity. Trophic level estimates were relative to the effect of carnivorous species. The estimate for the presence of distinct patterning was relative to the effect of the absence of distinct patterning.

Table 3.5 shows the bird species mentioned most by the WBT resources, and therefore highest popularity scores, the species with the highest predicted popularity scores based upon the model-averaged GLM, and the species with the largest positive and negative residual scores calculated by subtracting the predicted popularity scores from the actual popularity. The species with the largest positive residuals were suggested to be over-represented by the resources, and species with the largest negative residuals were suggested to be under-represented by the resources, relative to their traits. The R^2 for the model-averaged GLM was 0.1290, indicating weak correlation between observed and predicted species popularity (Fig.3.2; Cohen, 1988).

TABLE 3.5: The top ten ranking British bird species based upon the actual number of resources species were mentioned in, the predicted number of resources species were mentioned in, and the highest and lowest residual values. The predicted values were estimated by the model-averaged GLM. Residual values were calculated by subtracting the number of resources species were predicted to be mentioned in from the actual number of resources species were mentioned in.

Rank	**Species mentioned most in the resources**	**Resources mentioning species (no. of mentions)**	**Species with highest predicted mentions**	**Predicted source mentions**	**Species with largest negative residuals**	**Residuals**	**Species with largest positive residuals**	**Residuals**
1	Curlew *Numenius arquata*	8 (409)	Roseate tern *Sterna dougallii*	6.51	Collared dove *Streptopelia decaocto*	-4.98	Raven *Corvus corax*	2.39
2	Redstart *Phoenicurus phoenicurus*	8 (369)	Dotterell *Eudromias morinellus*	6.51	Parrot crossbill *Loxia pytyopsittacus*	-4.98	Skylark *Alauda arvensis*	2.02
3	Peregrine falcon *Falco peregrinus*	8 (337)	Whimbrel *Numenius phaeopus*	6.51	Magpie *Pica pica*	-4.61	Red crossbill *Loxia curvirostra*	2.02
4	Wood warbler *Phylloscopus sibilatrix*	8 (275)	White-tailed eagle *Haliaeetus albicilla*	6.51	Caspian gull *Larus cachinnans*	-4.61	Ptarmigan *Lagopus muta*	2.02
5	Pied flycatcher *Picedula hypoleuca*	8 (261)	Puffin *Fratercula arctica*	6.51	Mistle trush *Turdus viscivorus*	-3.27	Snow bunting *Plectrophenax nivalis*	1.85
6	Sedge warbler *Acrocephalus schoenobaenus*	8 (252)	Black-tailed godwit *Limosa limosa*	6.51	Woodpigeon *Columba palambus*	-2.98	Woodlark *Lulla arborea*	1.73
7	Kingfisher *Alcedo atthis*	8 (244)	Slavonian grebe *Podiceps auritus*	6.51	Stock dove *Columba oenas*	-2.98	Curlew *Numenius arquata*	1.73
8	Nightingale *Luscinia megarhynchos*	8 (235)	Shag *Phalacrocorax aristotelis*	6.51	Crane *Grus grus*	-2.98	Osprey *Pandion haliaetus*	1.49
9	Woodcock *Scolopax rusticola*	8 (228)	Lesser spotted woodpecker *Dryobates minor*	6.51	Balearic shearwater *Puffinus mauretanicus*	-2.61	Nightingale *Luscinia megarhynchos*	1.49
10	Reed warbler *Acrocephalus scirpaceus*	8 (227)	Yellow wagtail *Motacilla flava*	6.51	Marsh warbler *Acrocephalus palustris*	-2.51	Kittiwake *Rissa tridactyla*	1.49

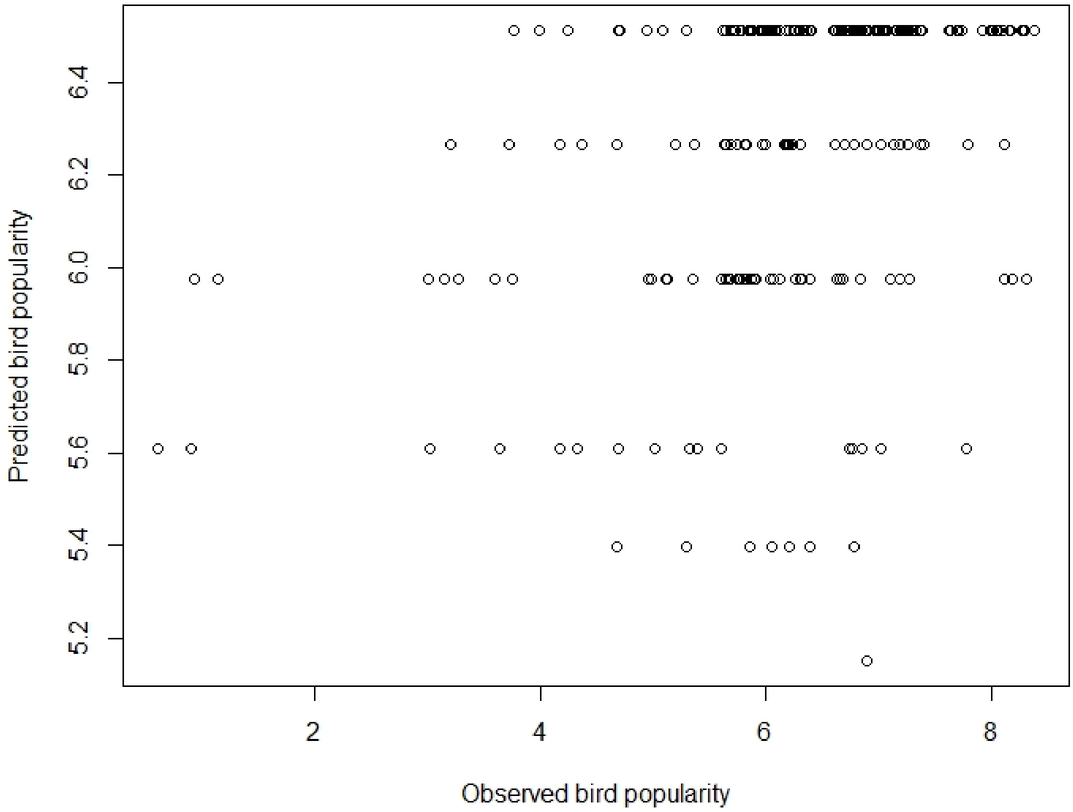

FIGURE 3.2: The relationship between the observed popularity of British bird species, based on the number of WBT resources they were mentioned in, and the predicted popularity of such species based upon the model averaged GLM. Plotted using a jitter function with a factor of 2.

Table A.12 in Appendix A describes the results of the global GLM for mammal popularity within the WBT resources. The model selection process yielded five top performing GLMs, including the null model, which best explained the popularity of mammal species across the WBT resources and it included three of the 12 attributes (Table 3.6).

TABLE 3.6: The top performing GLMs from the model selection process used to predict British mammal popularity. All models with df<4 and ΔAIC<6 were considered. Complex models with lower ΔAIC than simpler nested models were retained, following Richards (2008).

Model Rank	Variables in model	df	AICc	ΔAIC	weight
1	Sociality + range size + unusual adornments	4	160.1367	0.0000	0.3395
2	Range size + unusual adornments	3	160.1853	0.0485	0.3314
3	Range size	2	160.9617	0.8250	0.2247
4	Sociality	2	163.1724	3.0357	0.0744
5	N/A	1	164.9900	4.8533	0.0300

The model-averaged GLM for mammal species indicated that range size, sociality and unusual adornments influenced the popularity of mammal species (Fig. 3.3, see Table A.13 in Appendix A), though the effects were not found to be significant. Species with large range sizes tended to be mentioned most often by the WBT resources. The presence of unusual adornments tended to enhance the popularity of species. Solitary species tended to be mentioned more often than group-living species.

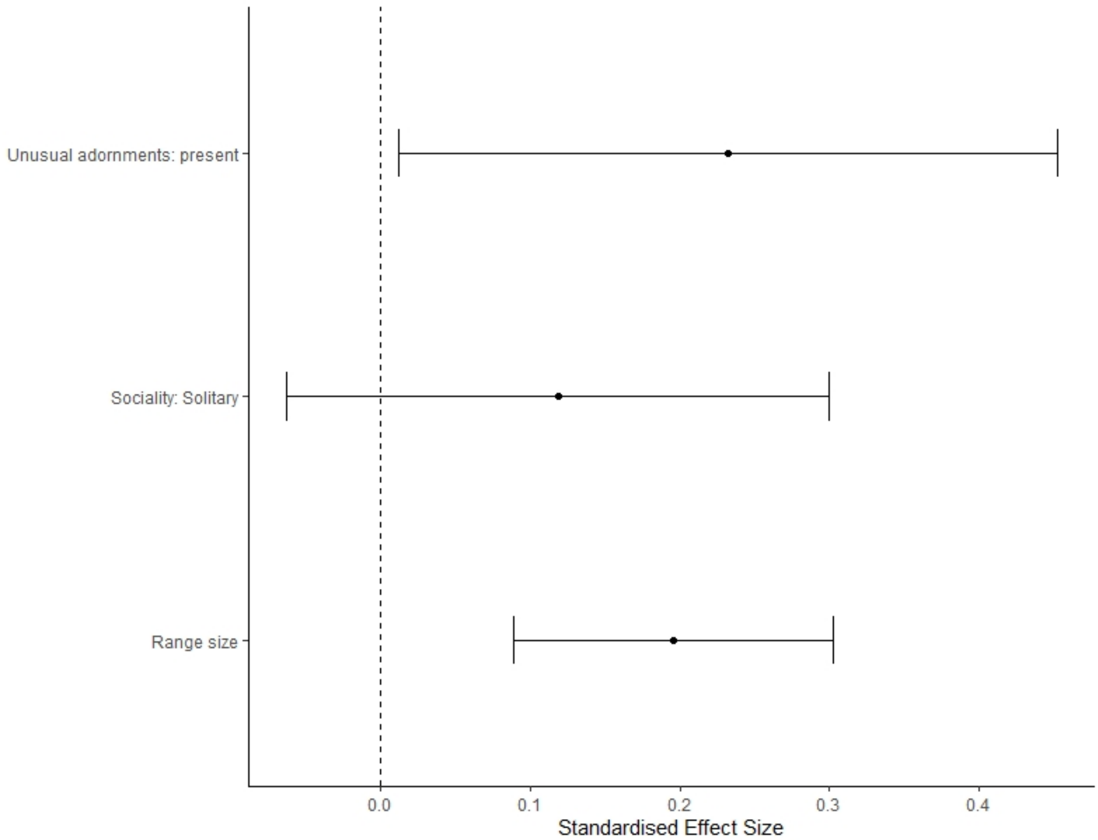

FIGURE 3.3: Standardised effect sizes of the model-averaged GLM coefficients for GB mammal popularity. The estimate for solitary species was relative to the effect of group-living species. The estimate for the presence of unusual appendages was relative to the effect of the absence of this trait.

Table 3.7 shows the mammal species with the highest popularity scores on the basis of the number of times such species were mentioned across the resources, the species with the highest predicted popularity scores derived from the model-averaged GLM, and the species with the highest and lowest residual scores calculated by subtracting the predicted popularity from the actual popularity. The R^2 for the model-average was 0.3530, indicating moderate correlation between observed and predicted species popularity (Fig. 3.4; Cohen, 1988).

TABLE 3.7: The top ten ranking British mammal species based on the actual number of resources species were mentioned in, the number of resources species were predicted to be mentioned in, and the highest and lowest residual values. The predicted values were estimated by the model-averaged GLM. Residual values were calculated by subtracting the number of resources species were predicted to be mentioned in from the actual number of resources species were mentioned in.

Rank	**Species mentioned most in the resources**	**Resources mentioning species (no. of mentions)**	**Species with highest predicted mentions**	**Predicted source mentions**	**Species with largest negative residuals**	**Residuals**	**Species with largest positive residuals**	**Residuals**
1	Otter *Lutra lutra*	8 (217)	Roe deer *Capreolus capreolus*	7.55	House mouse *Mus musculus*	-3.12	Hazel dormouse *Muscardinus avellanarius*	2.80
2	Red squirrel *Sciurus vulgaris*	8 (181)	Reeve's muntjac *Mantiacus reevesi*	6.60	American mink *Neovison vison*	-2.86	Pine marten *Martes martes*	2.72
3	Red deer *Cervus elaphus*	8 (163)	Rabbit *Oryctolagus cuniculus*	6.46	Eurasian beaver *Castor fiber*	-2.45	Water vole *Arvicola amphibius*	2.08
4	Water vole *Arvicola amphibius*	8 (82)	Hedgehog *Erinaceus europaeus*	6.36	Hedgehog *Erinaceus europaeus*	-2.36	Red squirrel *Sciurus vulgaris*	1.85
5	Hazel dormouse *Muscardinus avellanarius*	8 (63)	Red deer *Cervus elaphus*	6.35	Red-necked wallaby *Macropus rufogriseus*	-2.20	Mountain hare *Lepus timidus*	1.78
6	Pine marten *Martes martes*	8 (41)	Otter *Lutra lutra*	6.26	Common shrew *Sorex araneus*	-2.13	Otter *Lutra lutra*	1.74
7	Roe deer *Capreolus capreolus*	7 (236)	Brown hare *Lepus europaeus*	6.20	Wild boar *Sus scrofa*	-1.82	Red deer *Cervus elaphus*	1.65
8	Badger *Meles meles*	7 (208)	Stoat *Mustela ermine*a	6.17	Edible dormouse *Glis glis*	-1.28	Red fox *Vulpes vulpes*	1.44
9	Red fox *Vulpes vulpes*	7 (161)	Red squirrel *Sciurus vulgaris*	6.15	Weasel *Mustela nivalis*	-1.15	Badger *Meles meles*	1.41
10	Reeve's muntjac *Mantiacus reevesi*	7 (64)	Weasel *Mustela nivalis*	6.15	Grey squirrel *Sciurus carolinensis*	-1.12	Water shrew *Neomys fodiens*	1.36

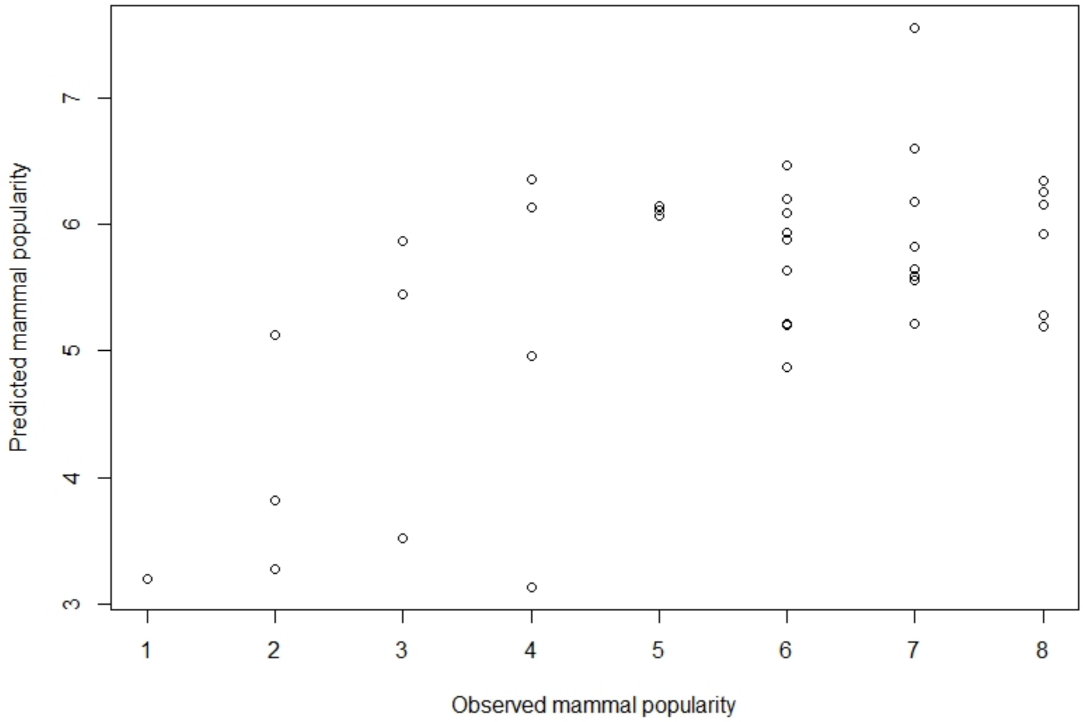

FIGURE 3.4: The relationship between the observed popularity of British mammal species, based upon the number of WBT resources they were mentioned in, and the predicted popularity of such species based upon the model averaged GLM.

3.3.2 Tourism Within Protected Areas

Table A.14 in Appendix A describes the results of the global GLM for British PA visitor numbers. The model selection process yielded three top performing GLMs which best explained the observed annual visitation of British PAs, including five of the nine attributes (Table 3.8).

TABLE 3.8: The top performing GLMs from the model selection process used to predict visitor numbers of British PAs. All models with ΔAIC<6 were considered following Richards (2008).

Model rank	**Variables in model**	**AICc**	**ΔAIC**	**weight**	**df**
1	Local catchment population + bird popularity + mammal popularity + temperature + habitat diversity	504.2228	0.0000	0.4308	7
2	Mammal popularity + habitat diversity	504.9179	0.6951	0.3044	4
3	Habitat diversity	505.1962	0.9734	0.2648	3

The model-average GLM for British PAs indicated that only habitat diversity had a significant ($p<0.05$) effect on visitor numbers (Fig. 3.5, see Table A.15 in Appendix A).

PAs with higher habitat diversity were found to attract the most visitors. The size of the local catchment population was found to positively influence tourism visitation. Mean monthly temperature was found to have a negative effect on tourism visitation, with sites located in cooler climates attracting more visitors. Bird and mammal popularity were also found have very small influences on the appeal of PAs to NB tourists, with low bird popularity and high mammal popularity attracting the most visitors.

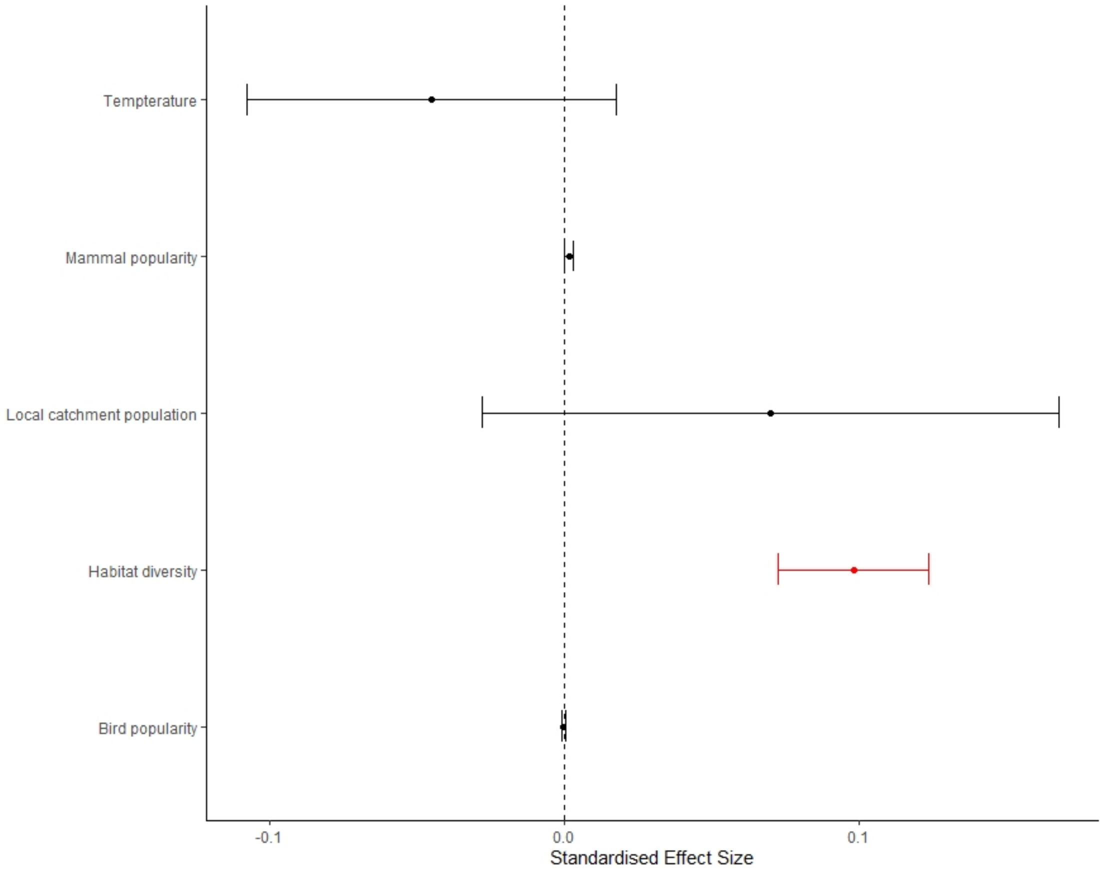

FIGURE 3.5: Standardised effect sizes of the model-averaged GLM coefficients for British PA visitation.

Table 3.9 shows the British PAs with the highest observed visitor numbers, the PAs with the highest predicted visitor numbers derived from the model-averaged GLM, and the PAs with the lowest and highest residual values. The R^2 for the model-averaged GLM was 0.0932 indicating weak correlation between the observed and predicted visitor numbers (Fig. 3.6; Cohen, 1988).

TABLE 3.9: The top ten ranking British PAs based upon the observed visitor numbers (n=213), the predicted visitor numbers and the highest and lowest residual values. The predicted values for all PAs for which complete trait data were available (excluding governance type category D PAs) were estimated by the model-averaged GLM (n=1924). For sites for which annual visitor numbers had been sourced, the predicted antilogarithm values were subtracted from the observed antilogarithm values to calculate residual values (n=213). All visitor numbers are given in antilogarithm form. For each PA, the World Database on PAs area ID code is given. (*) indicates data provided in confidence.

Rank	**PAs with the highest observed visitation**	**Observed visitation rate (1000s)**	**PAs with the highest predicted visitation**	**Predicted visitation (1000s)**	**PAs with the largest negative residuals**	**Residuals (1000s)**	**PAs with the larges positive residuals**	**Residuals (1000s)**
1	Studland and Godlingston Heath 11011	*	Firth of Forth 169840	143	Dee Estuary 183432	-42	Studland and Godlingston Heath 11011	1235
2	Holkham 1455	*	Purbeck 4860	123	Hamford Water 10976	-33	Holkham 1455	961
3	Mugdock Wood 139853	585	Morecambe Bay 137530	115	Blackwater Estuary 10948	-32	Mugdock Wood 139853	573
4	Yr Wyddfa 3233	449	North Yorkshire and Cleveland 4859	88	Nene Washes 137724	-30	Yr Wyddfa 3233	423
5	Stackpole 10560	350	Humber Estuary 193736	79	Haweswater 555581003	-30	Stackpole 10560	337
6	Clyde Valley Woodlands 11037	*	North Northumberland 4861	78	Havergate 555581081	-28	Clyde Valley Woodlands 11037	325
7	Loch Leven 1469	*	Suffolk 4858	76	Rum 1450	-28	Loch Leven 1469	277
8	Saltfleetby-Theddlethorpe Dunes 138114	*	Ben Nevis 136167	68	Geltsdale and Glendue Fells 137318	-24	Saltfleetby-Theddlethorpe Dunes 138114	275
9	Dyfi 1468	300	North Norfolk 4857	66	Forsinard Flows 387445	-24	Wyre Forest 11029	238
10	Newborough Warren 139609	252	Chichester Harbour 138593	63	Noss 1481	-22	Oxwich 11094	237

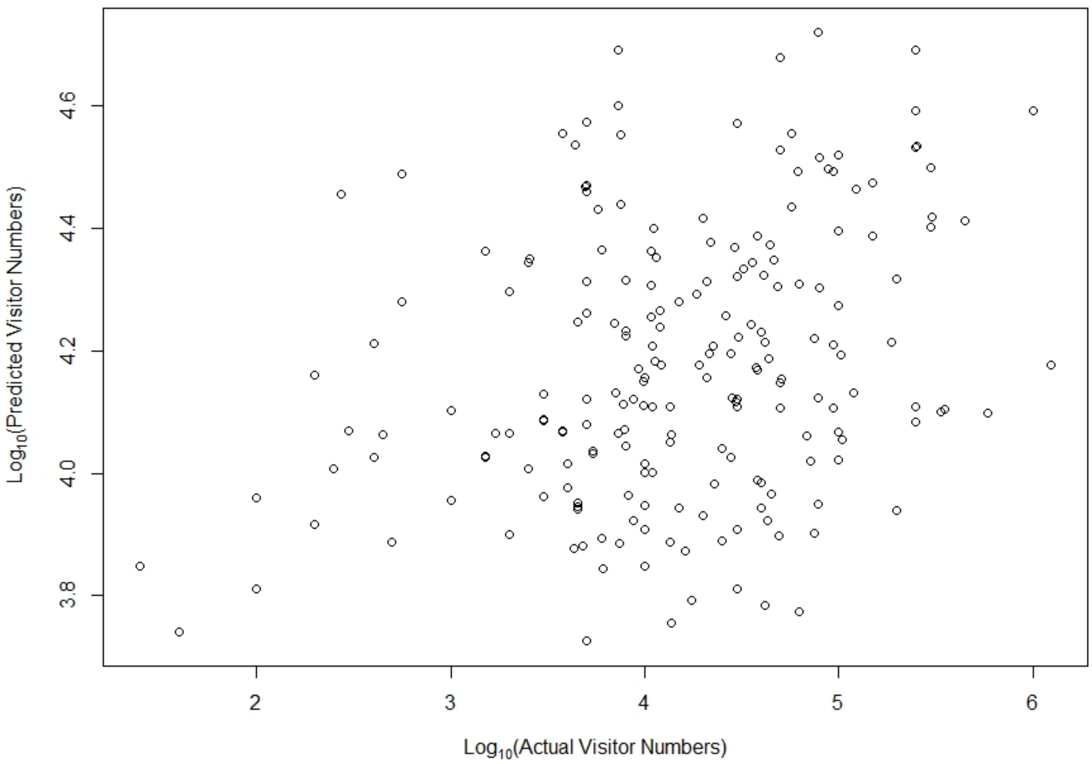

FIGURE 3.6: The relationship between the observed log_{10} visitor numbers to British PAs, and the predicted log_{10} visitor numbers based upon the model-averaged GLM. Only sites for which actual visitor numbers were sourced are shown (n=213).

3.4 Discussion

The results of this study provide insight into the characteristics of species which influence their appeal to wildlife-based (WB) tourists. The popularity of British birds tended to be driven by trophic level and plumage patterning. The popularity of British mammals tended to be driven by range size, sociality, and the presence of unusual adornments. The results of this study also provide insight into the attributes of PAs which can be used to predict visitor numbers. Visitor numbers to British PAs tended to be driven by habitat diversity, local population size, temperature, mammal popularity and bird popularity.

3.4.1 Traits Related to Species Popularity

National range size was found to influence the number of resources mammal species were mentioned in, with wide-ranging species, such as the European rabbit, *Oryctolagus cuniculus*, being more popular across the WBT resources than range restricted species, such as the edible dormouse, *Glis glis*, though not significantly. As discussed in Chapter 2, the influence of range size may be an artefact associated with the methodology, such that wider-ranging species are common across a greater number of PAs, therefore will be referenced in a greater umber of resources. Range size was not found to influence bird popularity, suggesting that alternative factors have greater importance in determining the tourism potential of this taxa.

Contrary to expectation, and to the findings discussed in Chapter 2, solitary mammals, such as the otter, *Lutra lutra*, were found to be more popular than group-living species, such as fallow deer, *Dama dama*, though not significantly. In GB, the ability to view congregations of mammals may be relatively poor compared to in African NPs, primarily due to the lack of open spaces. Furthermore, group-living British mammals may be habituated to human presence (e.g. EDIT, 2017), and therefore potentially less interesting to observe, despite the ability to view group behaviours such as play behaviour. Similarly, fascinating group behaviours which are known to attract tourists, such as the red deer rut, may only occur at certain times of the year. Therefore, group-living species may become temporarily popular to WB tourists, due to phenological shifts in behaviour, but in general, solitary species, and their behaviours, seem to be more appealing over the entire annual cycle, as suggested by this chapter. For example, solitary species with overlapping home ranges may regularly provide WB tourists with opportunities to observe territorial behaviours. Similarly, colonial birds were thought to be more appealing than non-colonial birds, however, the results do not support this, which may reflect the difficulties in accessing bird colonies (e.g. boat trips).

Carnivorous bird species were found to be more popular than herbivorous and omnivorous species, though not significantly. This could be associated with the aesthetic appeal of birds of prey (Kellert, 1989; Lišková and Frynta, 2013; Tremblay, 2002), such as the white-tailed eagle *Haliaeetus albicilla*. Likewise, the thrill of watching species hunt, or dive for fish, may appeal to many tourists (Dickie, Hughes, and Esteban, 2006; Lindsey et al., 2007) reflected by the popularity of the peregrine falcon, *Falco peregrinus*, kingfisher, *Alcedo atthis*, puffin, *Fratercula arctica*, shag, *Phalacrocorax aristotelis*, and terns, *Sterna sp.*. Such findings related to the exhibition of interesting or dramatic behaviours supports the idea that animal motion can influence tourist preference (Curtin, 2005; Reynolds and Braithwaite, 2001).

As reported in Chapter 2, physical appearance is suggested to contribute to the tourism potential of species, as colour and shape can influence a species attractiveness, and therefore aesthetic charisma (Barua et al., 2012; Frynta et al., 2010a; Frynta et al., 2011; Frynta et al., 2013; Knight, 2007; Lorimer, 2006; Lorimer, 2007; Macdonald et al., 2015; Small, 2012; Stokes, 2007; Veríssimo et al., 2009; Veríssimo et al., 2014; Veríssimo et al., 2017). Birds with distinct plumage patterning, such as the common kingfisher, *Alcedo atthis*, were found to be more popular than species with plain colouration, such as the common raven, *Corvus corax*, though not significantly. Birds with patterning may be more conspicuous, therefore enhancing their ecological charisma (Lorimer, 2007). The presence of distinct patterning did not influence the appeal of mammals, reflecting the greater importance of the presence of unusual adornments on species popularity. The presence of unusual adornments increased the popularity of mammal species, though not significantly, reflecting the aesthetic appeal of such traits.

3.4.2 Under- and Over-represented Species, Limitations and Recommendations

By determining which species characteristics appeal to tourists, the tourism potential of the birds and terrestrial mammals of GB were predicted. Species which are currently under-represented in the WBT resources, such as the hedgehog, *Erinaceus europaeus*, and mistle thrush, *Turdus viscivorus*, could be likened to "Cinderella species", as defined by Smith et al. (2012), i.e. they share characteristics with known attractor species, yet are overlooked as tourism attractors. The conservation of such species might benefit from increased marketing and public awareness, though this in turn can influence visitor pressure. On the other hand, species over-represented in the WBT resources may be experiencing "flagship fatigue" (see Bowen-Jones and Entwistle, 2002); such sites in which they reside could benefit from non-promotion of these species in order to raise awareness of wider biodiversity, thus supporting conservation initiatives and educating the public (Goodwin and Leader-Williams, 2000).

The weak correlation between the observed and predicted popularity values and the lack of significant explanatory variables suggest that the variance in the number of resources species are mentioned in could be accounted for by additional, underlying factors not considered by this analysis. These additional factors could explain why species are mentioned more, or less, often than expected by the modelling framework. Such factors may be difficult to quantify but could be considered in any future analyses.

The species identified as over-represented by the WBT resources, relative to their traits, as defined by their positive residual scores, may be more appealing than predicted by the modelling framework. Art, literature, social media, film and television are known to influence the familiarity of species to tourists, which may enhance their appeal (Tremblay, 2002; Veríssimo et al., 2017; Woods, 2000). For example, the osprey, *Pandion haliaetus*, is the brand logo of the Cairngorms NP and the badger, *Meles meles*, is the brand logo of The Wildlife Trusts. Similarly, the aesthetic appeal of red deer, *Cervus elaphus*, could be partially attributed to Landseer's "Monarch of the Glen" (Butler, 1985). Some of these sources can inaccurately portray species, particularly mammals, with anthropomorphic overtones which are known to appeal to tourists (Herzog and Galvin, 1992; Jones, 2000; Lorimer, 2007). For example, the legacy of "Mrs Tiggy-Winkle" from Beatrix Potter's work has previously been associated with the appeal of the hedgehog (Macdonald et al., 2015). In this study, the higher observed than predicted popularity of the red squirrel, *Sciurus vulgaris*, red fox, *Vulpes vulpes*, and badger could similarly be associated with Potter's "Squirrel Nutkin", "Mr Todd", and "Tommy Brook", respectively. The familiarity of the red fox may also be associated with the legacy of the *The Fox and the Hound* and the otter and water vole, *Arvicola amphibious*, popularity attributed to the legacy of *The Wind in the Willows*.

The popularity and high perceived willingness-to-pay (e.g. White et al., 1997) for the preservation of the red squirrel and otter may also be influenced by their flagship status, being emblems of British natural heritage (Battersby, 2005; Macmillan and Phillip, 2008; White et al., 1997). Moreover the actual appeal of species to tourists may further be accredited to public awareness of their population declines and extinction threat from habitat fragmentation (e.g: water vole and hazel dormouse, *Muscardinus avellanarius*, Battersby, 2005, Morris, 2003; otter, Kruuk, 1995; skylark, *Alauda arvensis*), water pollution (e.g. water vole and otter, White et al., 1997), overfishing (e.g. kittiwake, *Rissa tridactyla*, Fowlie, 2018), predation, disease or competition from invasive species (e.g: water vole, Barreto et al., 1998; red squirrel, Battersby, 2005; Dunn et al., 2018), climate change (e.g: water vole and hazel dormouse, Battersby, 2005; Macdonald and Tattersall, 2001; kittiwake, Fowlie, 2018, historical pesticide use (e.g. osprey and otter, Battersby, 2005), and human persecution (e.g. osprey, red fox and badger).

The higher than predicted popularity, and associated familiarity, of species may also be associated with localised ranges, such as those of ptarmigan, *Lagopus muta*, snow bunting, *Plectrophenax nivalis*, osprey, nightingale, *Luscinia megarhynchos*, woodlark, *Lulla arborea*. In addition, species with expanding ranges into England and Wales, naturally or through assistance, such as the pine marten, *Martes martes*, may also see an increase in public awareness and interest. Familiarity and appeal could also be attributed to widespread consumptive use, and functional charisma (Lorimer, 2006) of species, for example, the positive residual scores of red deer and red fox could be associated with sport hunting, or sale of venison for the former (Battersby, 2005; Butler, 1985; Macmillan and Phillip, 2008). Tourists may also have an affinity for bird song and musicality (Rothenberg et al., 2014), potentially reflecting the positive residual scores of the curlew, *Numenius arquata*, nightingale and skylark. Alternatively, cultural and mythological depictions may influence species familiarity and perceived appeal. For example, ravens commonly associated with the Tower of London (AboutBritain, 2020) and emblems of heraldry, are very complex symbols, also widely revered as psychopomps and omens or messengers of death, particularly with relation to Odin the Norse God of war and death (Horowitz, 1981), and Apollo, the Greek God of prophecy.

The physical appearance traits collated in this study do not fully represent the variance in species aesthetic appeal. For example, the methodology did not encapsulate seasonal plumage or pelage colouration, therefore species with changing colouration, such as the ptarmigan and mountain hare, *Lepus timidus*, may appeal to tourists more than suggested by the modelling framework. Likewise, this study did not quantify "cuteness", it only referenced traits which are thought to influence "cuteness", such as large eyes (Jones, 2000; Lorenz, 1943; Morreall, 1991; Reynolds and Braithwaite, 2001). Such contributing traits may have been masked by the binary "unusual appendages" and "unusual adornments" categories, therefore underestimating the actual physical appeal of species such as the water shrew, *Neomys fodiens*. The hazel dormouse with its large forward-facing eyes, big ears and long fluffy tail, is a prime "over-represented" example of a "cute" species likely to stimulate an emotional response from tourists (Morris, 2003).

Similarly, under-represented species relative to their traits, classified by their negative residual scores, may possess additional characteristics which make them less appealing than predicted for tourism. For example, species which can easily be seen in gardens or urban areas such as the house mouse, *Mus musculus*, hedgehog, common shrew, *Sorex araneus*, grey squirrel, *Scirurus carolinensis*, collard dove, *Streptopelia decaocto*, magpie, *Pica pica*, mistle thrush, *Turdus viscivorus*, woodpigeon, *Columba palambus*, and Stock dove, *Columba oenas*, may be less likely to be utilised by the WBT resources to attract tourists to PAs. On another hand, species which are difficult to observe due to elusiveness (e.g. Eurasian beaver, *Castor fiber*) small breeding populations (e.g. parrot crossbill, *Loxia pytyopsittacus*; crane, *Grus grus*; marsh warbler, *Acreocephalus palustris*) or accessibility (e.g. balearic shearwater, *Puffinus mauretanicus* may appeal less to tourists than predicted by the modelling framework.

The popularity of non-native species such as the American mink, *Neovison vison*, red-necked wallaby, *Macropus rufogriseus*, and edible dormouse, seems to be lower than expected by the models. The low actual tourism potential of American mink could also be attributed to its threat towards British natural heritage (Macdonald and Strachan, 1999; Macdonald and Tattersall, 2001; Macmillan and Phillip, 2008). Similarly species such as the house mouse, American mink, common shrew, wild boar, edible dormouse, weasel, *Mustela nivalis*, collard dove, magpie, woodpigeon, stock dove and Caspian gull, *Larus cachinnans*, may in reality be poor tourism attractors due to their perceived status as pests, vermin or scavengers (Battersby, 2005; Curtin, 2005; Curtin and Wilkes, 2005; Macmillan and Phillip, 2008; Morris, 2003; Sheail, 1999; Wilson, 2004). Moreover, species which act as vectors of diseases, such as house mouse (Macdonald and Tattersall, 2001), wild boar (Wilson, 2003), and American mink (Battersby, 2005) will not appeal to tourists as predicted. The existence of animal phobias may further contribute to the lower observed than predicted popularity of mice and shrews (Knight, 2007).

The relatively new methodology used in this study to define species popularity based upon the WBT resources has limitations. Firstly, threatened or range restricted species, such as cranes, may rarely be listed in tourism resources, even if they are highly attractive to tourists, in order to protect them, akin to the RSPB website. The resources utilised are also not up to date, potentially underestimating the actual popularity of recently reintroduced species such as the Eurasian beaver, or species previously considered as subspecies, such as the Caspian gull. A few of the older sources utilised are from the 1980s and their current content may also not reflect the changing attitudes and preferences of the public to wildlife, which change over time with increased awareness and experience (Bryan, 1977). Also, the species listed in the resources are chosen based upon the author's perceptions of what appeals to tourists, albeit that such authors usually have extensive experience of WBT in GB. Therefore, the author's personal experiences, culture, knowledge, and photographic expertise will manifest in the estimated appeal of species based upon this methodology, as discussed in Chapter 2 (Douglas and Winkel, 2014; Kellert et al., 1996; Linnell, Swenson, and Andersen, 2000; Macdonald et al., 2015; Martín-López, Montes, and Benayas, 2007; Tisdell, Nantha, and Wilson, 2007; Zillinger, 2006). Thus, additional resources are required to reduce bias associated with author preferences. Additional resources could also provide beneficial as only eight resources were considered in this study, therefore there was little variance in species popularity (compared to in Chapter 2). Another potential bias in the method of collecting species popularity data is that the reference resources were intentionally focused on publications presenting multi-taxa, nationwide assessments. Such resources may appeal to the more generalist tourists, whereas specialists (with interest in e.g. particular taxonomic groups, or particular regions) may have differing preferences. With more time, additional taxa and region-specific resources would assist in looking for commonalities and difference in inference.

3.4.3 Traits Related to Protected Area Visitor Numbers

In accordance with Chapter 2, this chapter highlights the importance of habitat diversity in influencing PA visitor numbers. PAs with a greater diversity of habitats were found to attract more visitors, potentially due to the greater range of biodiversity and authentic, natural settings present at these sites, which are known to appeal to NB tourists (Fredrickson and Anderson, 1999; Markwell, 2001; Schänzel and McIntosh, 2000). As mentioned in Chapter 2 open grasslands and moorlands enhance wildlife viewing visibility (Gray and Bond, 2013; Kerley, Geach, and Vial, 2003; Kiss, 2004), yet wooded areas provide shielding to the observer (Curtin, 2005). Mountainous or coastal areas, such as the Highlands and Islands of Scotland may interest geologists and geographers, as well as attracting NB-tourists with scenic views over natural landscapes (Powell et al., 2012). Additionally, rivers, water bodies and coastal areas may provide tourists with the opportunity to observe wildlife aggregations (e.g. overwintering migrants, Jackson, Kershaw, and Gaston, 2004; Reynolds and Braithwaite, 2001) and interesting wildlife behaviours (e.g. hunting, Beerens, Trexler, and Catano, 2017; Gatto, Quintana, and Yorio, 2008), and to participate in water sports. Not all habitat types are equally as important at all points of the year due to phenological and climatic cycles, therefore, greater habitat diversity may offer greater visitor usage as they have year-round appeal.

The size of the local catchment population was also found to increase tourism visitation, though not significantly. The positive effect is supported by the spatial demand model (Hanink and Stutts, 2002) which suggests that the greater the local catchment population, the greater the potential user population. For example, 95% of visitors to the Scottish Wildlife and Countryside Fair at RSPB Loch Leven come from within a 50-mile radius (Shiel, Rayment, and Burton, 2002). It may also be important to consider how the catchment population within each PA holds visitor potential. In some situations, the local population size may have less impact on visitor numbers, hence the non-significant effect. For example, remote places such as the Highlands and Islands of Scotland tend to have increased visitor appeal due to their remote nature (Butler, 1985; Lennon and

Harris, 2020). These less accessible, unique destinations can support abundant wildlife (Curtin, 2010) and a greater "sense of place" (Barendse et al., 2016; Hausmann et al., 2016; Hausmann et al., 2017b), and hence attract many visitors despite low densities of local residents. The size of the local catchment population may also be less important in driving tourists to PAs which host rare species as people may be willing to travel further to see such species.

Climatic variables, such as temperature and precipitation influence tourism (Richardson and Loomis, 2004). In this chapter, temperature was found to negatively affect tourism visitation, though not significantly, with cooler destinations receiving more visitors, on average, than warmer destinations. Sites at higher elevations and latitudes, such as the Highlands and Islands of Scotland are generally cooler and have restricted plant growth, providing open areas which provide greater wildlife-viewing opportunities (Gray and Bond, 2013; Kerley, Geach, and Vial, 2003; Kiss, 2004). Such cooler destinations further provide the public with non-wildlife viewing activities, reflected by the number of people that participate in sightseeing, snow-sports, mountaineering (e.g. Cairngorm, Glen Coe) and hiking (e.g. Ben Nevis, Yr Wyddfa, Beedie and Hudson, 2003). PAs located in warmer areas, however, may also provide popular tourism activities, such as coastal walks (e.g. the Jurassic Coast), hence the non-significant effect.

Wildlife popularity (bird and mammal popularity) was found to have very small and non-significant effects on tourism visitation to GB PAs, suggesting that many tourists visiting PAs are not WB-tourists. Despite the growing population of people participating in bird watching in Britain (Dickie, Hughes, and Esteban, 2006), bird popularity was found to be negatively correlated with visitor numbers. This may reflect the absence of known tourism attractor species (e.g. rare vagrants not classified under the Birds of Conservation Concern) from this study. Therefore, future methods could consider all bird species recorded across GB (especially as BCC status was not found to influence bird popularity as expected). Mammal popularity was found to be positively correlated with visitor numbers. Many PA managers, however, such as the RSPB, and advisory organisations, such as the Game and Wildlife Conservation Trust, facilitate the control of vermin (e.g. grey squirrel) and predator species (e.g. red fox) in order to maintain viable populations of threatened species, especially ground-nesting birds such as the Eurasian curlew, *Numenius arquata*, and red grouse, *Lagopus lagopus* (e.g. Geltsdale and Glendue Fells; Battersby, 2005; Norberg, 1999; Shiel, Rayment, and Burton, 2002). Some PAs also manage deer species in order to reduce damage to forestry (Battersby, 2005). Therefore, despite their presence in PAs, many mammal species classified as pests, vermin, or predators, may not actually attract visitors in reality, hence the non-significant effect.

Additionally, the species occurrence data used to estimate the bird and mammal popularity of a PA are dependent on recording effort. Therefore, the estimated values for each site may be lower than in reality due to under-recording of species. Additionally, the bird and mammal popularity values were calculated based upon the mean values of each 10km cell found within each PA. Therefore, the calculated values reflect the distribution of a species within a PA. A species which is highly popular in the WBT resources but only found (recorded) within a specific section of a PA will contribute less to the wildlife popularity of a PA than a popular species located (recorded) throughout the entire PA. Based upon this, a PA with a low wildlife popularity metric which actually hosts a species with high tourism potential within a specific area of the site may actually be a novelty, and therefore attract more tourists than predicted by the modelling framework (e.g. ospreys found at Loch Garten within the Abernethy).

3.4.4 Under- and Over-utilised Sites, Limitations and Recommendations

This chapter assess the value of NBT in GB by providing estimates for PA tourism visitation. By determining which site attributes appeal to the public, currently over- and under-utilised PAs, relative to their traits, have been recognised. Overutilised sites may be experiencing breaches of social and ecological carrying capacities, and therefore could potentially benefit from reduced visitor pressure and associated strengthened management and marketing (Armstrong and Kern, 2011). Underutilised sites may not possess the most appealing attributes, or may be lacking in the marketing sector, therefore could potentially benefit from increased public awareness, in turn providing economic benefits to the local economy (Crabtree et al., 1994; Rayment and Dickie, 2001).

The weak predictive power of the modelling framework and the lack of significant predictor variables suggests that the variance in mean annual visitor numbers to PAs can be accounted for by additional, underlying factors that have not been considered in the analysis. Such factors may be difficult to quantify (e.g. "sense of place"), or difficult to compile (e.g. presence of visitor facilities), but could be considered in future analyses. Here, with reference to the PAs with the highest and lowest residual scores, additional explanations for tourism visitation are examined.

PAs which provide tourists with informative details of their site (e.g. RSPB reserves) may attract tourists more, or less, often than predicted by the modelling framework. For example, the RSPB website provides details on site opening times, entrance fees, facilities, accessibility, weather forecasts, trails guides, star species, recent sightings, seasonal highlights, events, habitat types, conservation initiatives, blog posts and additional leisure activities. Such promotional material may attract more tourists than expected (e.g. Loch Leven), or less than expected (e.g. Haweswater) (Armstrong and Kern, 2011), as described in the paragraphs below. Similarly, PAs and their features which are promoted by tourism guidebooks (e.g. those referenced in this study) may appeal more to tourists than predicted (Zillinger, 2006). The effect of site popularity in guidebooks on tourism visitation is currently being explored in a global study conducted by PhD student, Kirkland (2020).

Facilities and infrastructure distributed within PAs will typically attract masses of generalist tourists, including large groups of pensioners and school groups (Duffus and Dearden, 1990; Weaver, 2001). For example, Vane Farm at Loch Leven hosts up to 200 school groups each year, as well as the Scottish Wildlife and Countryside Fair. Such uses are only possible due to the presence of educational facilities, toilets and expansive car parking (Shiel, Rayment, and Burton, 2002). On the other hand, sites which do not possess visitor centres or facilities may appeal less to tourists than predicted by the modelling framework. For example, minimal tourist facilities can be found at RSPB Parkgate in the Dee Estuary, Haweswater, Rum, Blackwater Estuary, Nene Washes, Havergate Island, and Geltsdale and Glendue Fells.

Similarly, some PAs may have restricted access which in reality will have lower tourism potential than expected by the predictions. For example, the car park at Blackwater Estuary is closed on weekends, the road to Haweswater has a dead-end, the visitor centre at Forsinard Flows is only open April-October, and ferry access to Noss is restricted to May-August. Some PAs which require boat access (e.g. Rum) have further restrictions related to boat timetables. If not planned accurately, this could force tourists to stay the night on the island in limited accommodation with few amenities or result in poor visitor satisfaction. Such tourist trips typically attract WBT specialists, adventure tourists, "backpackers", or those seeking a "sense of place" (Beedie and Hudson, 2003; Orams, 2002; Walker et al., 1998; Weaver, 2001).

Many sites in GB are open access and have no visitor recording systems. Therefore, observed visitor numbers used in this study may be inaccurately estimated, or not reflect the entire visitor pool (e.g. jointly managed PAs as previously mentioned). This may also explain why the size of the PA was found to have no effect on tourism visitation (i.e. larger areas have more access points). The use of inaccurate or estimated visitor numbers creates significant implications for NBT research as such sites may incorrectly be classified as under-utilised by tourists when in reality they may be suffering from high levels of tourism pressure and environmental degradation and therefore would not necessarily benefit from increased marketing or promotion. Such sites with high positive residual values potentially reflecting inaccurate observed visitor numbers include Geltsdale and Glendue Fells, Dee Estuary, Blackwater Estuary, Nene Washes, Haweswater and Hamford Water. Alternatively, some sites may also be incorrectly identified as under-utilised by tourists when they may have actually developed strengthened tourism management, including restrictions on the number of tourists which can enter the site in order to reduce the negative effects of visitors (e.g. access to Havergate Island requires a pre-booked boat trip).

As the tourist market is extremely heterogeneous, it is difficult to discern those participating in WBT from those with alternative motivations. Doing so would require costly, time consuming surveys or interviews (Curtin, 2005; Hausmann et al., 2017a). It could, however, prove beneficial to consider the additional activities or features located within PAs and their surrounding areas which could contribute to the performance of sites within the tourism industry. Appealing features may include aesthetic, undisturbed landscapes

(Balmford et al., 2015; Beedie and Hudson, 2003; Curtin, 2005; Goodwin and Leader-Williams, 2000) which are romantically portrayed within the English literature. For example, Studland and Godlingston Heaths from Thomas Hardy's work, or the Scottish Highlands from the works of Sir Walter Scott, Wordsworth, Burns, Dickens and Tennyson (Butler, 1985). Additional characteristics which influence tourism visitation may include historical, archaeological and cultural significance (Butler, 1985; Dickie, Hughes, and Esteban, 2006; Zillinger, 2006), local guiding (Curtin, 2010), leisure or game hunting (Butler, 1985), or relaxation features such as beaches (Curtin, 2005).

Specifically relating to the sites with high residual values, Mugdock Wood and Clyde Valley Woodlands encompass Mugdock Country Park and Chatelherault Country Park, respectively. Holkham borders a holiday park and Holkham Hall and gardens, with boat and cycle hire. Holkham and Loch Leven provide activities associated with recreational game shooting and fishing. Mugdock and Clyde Valley Woodlands could also be seen as dog walking hot spots. Stackpole and the Wyre Forest could be seen as adventure and family tourism hot spots, offering activities such as mountain biking, and Go Ape (Wyre Forest only). Holkham, Stackpole and Oxwich lie on the unspoiled Norfolk, Pembrokeshire and Gower coastal paths, respectively, and also lie within PAs designated as AONBs. Stackpole, Yr Wyddfa (Snowdon) and the Clyde Valley Woodlands are further associated with aesthetic landscapes and geological attributes which are known to appeal to tourists (Goodwin and Leader-Williams, 2000; Packer, Ballantyne, and Hughes, 2014). Most notably, Yr Wyddfa is the highest peak in Wales, rendering it as part of the National Three Peaks Challenge, thus attracting many generalist tourists aiming to summit in minimal time, without appreciating what the site has to offer. Similarly, the access of generalist tourists to Yr Wyddfa is facilitated by the mountain railway, and specialist, thrill-seeking, adventure-tourists are attracted to the natural geological features of the PA (Beedie and Hudson, 2003). Alternatively, Rum may be less appealing than expected by the modelling framework due to the lack of non-NBT activities present on the island, and similarly, the Cumbrian fells of Geltsale and Glendue may not attract as many tourists as expected due to the nearby Lake District NP. Therefore, when evaluating the social carrying capacities of PAs and drivers of visitation, it may provide beneficial to consider alternative nearby attractions and spatial auto-correlation between sites.

The findings of this chapter suggest that the wildlife present at a site can influence it's tourism potential. The bird and mammal popularity metrics developed for this study, however, do not provide sufficient insight as to what specifically interests tourists. For example, the availability of additional taxa (e.g. marine mammals, plants, feral species) and the abundance of species (e.g. breeding colonies of birds) were not contemplated by this study but have previously been found to influence tourism (Curtin, 2010; Jackson, Kershaw, and Gaston, 2004; Reynolds and Braithwaite, 2001), and therefore could be considered in any future study. The effect of phenological cycles on tourism could also be investigated as some sites may be highly popular for tourism at only certain points in the year (e.g. spring bird migration). Many sites also possess features which aid wildlife watching, such as guided walks, binocular hire, viewing hides and nest cameras linked up to social media (e.g. Dickie, Hughes, and Esteban, 2006). Such features help tourists to establish a greater connection with nature, and therefore fulfil a "sense of belonging" (Barendse et al., 2016; Hausmann et al., 2016; Lemelin, 2006; Sharpley and Sundaram, 2005; Tuan, 1997).

Specifically relating to the sites with high residual values, tourists may be attracted to Studland and Godlingston Heath to view wintering wildlife, all six native reptile species, and the range restricted Dartford warbler, *Sylvia undata*. Holkham supports large numbers of wintering wildlife, little tern, *Sternula albifrons*, breeding colonies, natterjack toads, *Epidalea calamita*, and dune flowers. Stackpole hosts one of the largest populations of greater horseshoe bats, *Rhinolophus ferrumequinum*, in Britain, displays of spring flowers and breeding colonies of chough, *Pyrrhocorax pyrrhocorax*; a species known to attract tourists to other parts of Britain (e.g. The Lizard, Dickie, Hughes, and Esteban, 2006). The ancient woodlands of the Clyde Valley possess carpets of spring woodland flowers, summer songbirds and autumnal fungi. Saltfleetby-Theddlethorpe holds wildflower meadows and Hebridean sheep. Loch Leven is an internationally important site for wintering wildfowl, supporting 5% of the world's pink-footed goose, *Anser brachyrhynchus*, population (Shiel, Rayment, and Burton, 2002), 6% of Scotland's population of wintering Whooper swans, *Cygnus cygnus*, and the world's first bumble-bee sanctuary.

As mentioned in Chapter 2, there are additional macro- and micro-scale factors which influence the decisions that tourists make when choosing a NB destination (Ajzen, 1988). Imagery and conceptions of nature developed through social media, television and film may drive tourists to specific PAs where they believe they will experience up-close and personal wildlife encounters (Bulbeck, 2005). For example, people may visit the Cairngorms due to the romanticised perceptions developed through BBC Winterwatch (Curtin, 2013a). Many other tourists may also wish to visit a site simply to take pride in themselves by summiting a mountain or ticking off a species from their list (Beedie and Hudson, 2003; Bulbeck, 2005; Curtin, 2005; Desmond, 1999; Rasmussen, 1964).

Similarly, personal attitudes towards nature, tourism and sustainability, and levels of education (Curtin, 2005; Jackson, 1986; Schultz et al., 2004; Weaver, 2001; Xu and Fox, 2014), thoughts of fantasy, mythological construction, escapism, and existential authenticity (Beedie and Hudson, 2003; Curtin, 2005; Fredrickson and Anderson, 1999; Grünewald, Schleuning, and Böhning-Gaese, 2016; Lemelin, 2006; Rojek and Urry, 1997), and culture and socio-economic demographics (Beedie and Hudson, 2003; Cousins, 2007; Curtin, 2005; Diamantis, 1999; Ressurreição et al., 2012; Xu and Fox, 2014) are ingrained in tourist motivations, expectations and distributions.

These factors are further associated with the socially constricted "sense of place", of which many seek through travel and tourism (Barendse et al., 2016; Curtin, 2005; Hausmann et al., 2016; Lemelin, 2006; Millenium Ecosystem Assessment, 2005; Sharpley and Sundaram, 2005; Tuan, 1997; van den Berg, Koole, and Wulp, 2003). Such personal aspects often develop as tourists progress, with increasing levels of knowledge, experience and equipment, through the LSC (Bryan, 1977; Duffus and Dearden, 1990; Reynolds and Braithwaite, 2001). Indeed, the motivations of this heterogeneous population of PA users, and their levels of satisfaction, will ultimately drive PA management actions (Akama and Kieti, 2003; Curtin, 2005; Eagles, 2014; Ferreira and Harmse, 2014), therefore rendering the understanding of what drives their participation in NBT, a requirement.

3.5 Conclusion

This chapter has explored the characteristics which define the WBT potential of bird and terrestrial mammal species in GB, using freely available data from tourism resources. The drivers of tourism to British PAs have also been explored with the use of visitor number records. Species which are currently over- or under-represented by tourism resources, relative to their traits, and sites which are currently over- or under-utilised by tourists, relative to their traits were identified. Changes in marketing and management, as will be reported in Chapter 5, are required to generate an equilibrium between visitor pressure and expectations, benefits for local people, economic revenue, and sustainable conservation management. Future research should investigate additional attributes which could contribute to the potential tourism appeal of both species, e.g., threat to native species, and PAs, e.g., presence of visitor facilities. The results show that additional tourism resources could be consulted to provide greater insight into the popularity of British species to tourists. The results also show that visitation data is patchy in occurrence and potentially variable in its consistency. There is an urgent need for a more comprehensive, systematic study of visitor numbers to natural areas to better understand what motivates visitors. Similarly, the current work flags the need for more consistent, collaborative monitoring techniques for visitors, one of which is piloted in Chapter 4.

Chapter 4

The Use of Modified Infrared Cameras as Visitor Recorders in Great British Protected and Recreational areas

4.1 Introduction

4.1.1 The Importance of Monitoring Visitors

As noted in the previous chapters, the conflict of interest between economic growth and nature conservation underpins the need to better understand visitor pressure and impact. Unfortunately, visitor use and impact is widely thought to be inadequately measured and described (Cessford and Muhar, 2003; Cope, Doxford, and Probert, 2000; Curtin, 2005; Watson et al., 2000).

Visitor count data can assist managers in making informed decisions and strategic plans (Reynolds and Elson, 1996; Phillips, 1998). For example, (1) identification of key sites and problem hotspots which may require allocation of infrastructure and services, visitor regulation or changes in marketing and promotion, (2) scheduling of staff, provision of resources and maintenance, (3) identification of the socio-economic and political use of areas which can attract external funding, advocate investment into service and resource provision and justify protected area (PA) designation, (4) identification of relationships between use-levels and recreational impacts to predict and evaluate the responses of visitor types to management decisions, (5) developing trend indices and generating performance indicators for visitor flow modelling (Arnberger, Haider, and Brandenburg, 2005; Cessford, Cockburn, and Douglas, 2002; Cessford and Muhar, 2003; Cope, Doxford, and Probert, 2000; Eagles, 2014; Hornback and Eagles, 1999; Keirle, 2002; Melville and Ruohonen, 2004; Phillips, 1998; Vuorio, Emmelin, and Sandell, 2003; Watson et al., 2000).

The success of sustainable management policies, visitor impact assessments and visitor flow modelling are dependent on the accuracy and reliability of the visitor count data recorded (Cessford and Muhar, 2003). Traditionally, PA managers have relied on guesswork and verbal reports from visitors to make decisions (Arnberger and Hinterberger, 2003) and, surprisingly, this is still the case for most PAs in Great Britain (GB). Unfortunately, unnecessary product development and environmental strain may result from overestimates of tourism demand (Moscardo and Saltzer, 2004). More accurate monitoring and recording is facilitated by mechanical and electronic counting devices (Lynch et al., 2002).

4.1.2 Methods of Monitoring Visitors

Over recent decades, many have trialled and summarised the numerous visitor recording approaches within PAs and recreational areas (RAs) (Arnberger, Haider, and Brandenburg, 2005; Cessford and Muhar, 2003; Cope and Doxford, 1997; Cope, Doxford, and Probert, 2000; Gasvoda, 1999; Hornback and Eagles, 1999; Melville and Ruohonen, 2004; Vuorio, Emmelin, and Sandell, 2003; Watson et al., 2000). The use of these devices is typically dependent on time, funding and human resources available for deployment, maintenance, and interpretation (Cessford and Muhar, 2003). Further, different approaches can be used in combination for calibration purposes or to enhance their accuracy and reliability. Insight into the costs and benefits of these approaches are provided in Table 4.1 in short.

TABLE 4.1: A summary of the advantages and disadvantages of direct, electronic, and mechanical approaches of recording visitors to destinations, as well as references for examples and discussions of the various methods. Adapted from Cessford and Muhar (2003).

Recording type	**Advantages**	**Disadvantages**	**Examples of studies**
Field observations	Mobile, accurate, can record visitor characteristics (e.g. age, membership, equipment, behaviour), can be used to calibrate alternative methods	Requires on-site staffing, can be subjective, will not record all visitors	Arnberger, Brandenburg, and Muhar (2002) Arnberger and Hinterberger (2003) Arnberger, Haider, and Brandenburg (2005) Cope and Doxford (1997) Gätje, Möller, and Feige (2002) Hinterberger, Arnberger, and Muhar (2002) Keirle (2002) Krämer and Roth (2002) McIntyre (1999) Visschedijk and Henkens (2002)
Visit registrations (e.g. registers, fee payment, permits)	Cheap, simple, flexible, accurate, can record visitor characteristics (e.g. age, membership, equipment, behaviour)	Response rates vary due to the voluntary approach, visitor centres or staff may be required (thus can be expensive and time consuming)	McIntyre (1999) Rundle (2002)

Inferred counts (e.g. indicative counts and interviews)	Provides visitor profiling data (e.g. motivations and opinions)	Opportunistic, requires major calibration, interviews are voluntary, requires staffing and does not provide accurate count data	Arnberger, Brandenburg, and Muhar (2002) Arnberger and Hinterberger (2003) Cope and Doxford (1997) Gätje, Möller, and Feige (2002) Hinterberger, Arnberger, and Muhar (2002) Krämer and Roth (2002) McVetty (2002) Visschedijk and Henkens (2002)
Camera and video recordings	Accurate, can record visitor characteristics (e.g. equipment), can be used long term, time and date reference recorded	Static, expensive equipment, staff required on-site for maintenance, and off-site for decoding and interpretation, subject to vandalism and theft, dependent on electronic functioning, subject to privacy concerns	Arnberger, Brandenburg, and Muhar (2002) Arnberger and Hinterberger (2003) Arnberger, Haider, and Brandenburg (2005) Ditton, Fedler, and Graefe (1983) Hinterberger, Arnberger, and Muhar (2002) von Janowsky and Becker (2003)
Remote sensing (e.g. aerial/ satellite imagery)	Covers large spatial scale, can give inferred counts from impacts of tourism on the landscape (e.g. footpath erosion)	Subject to weather and vegetation conditions, expensive equipment, mobile, periodic use	Rodway-Dyer and Ellis (2018)

Mechanical counts (mounted to gates, stiles etc.)	Cheap maintenance, requires little staff time	Mount subject to wear and tear, thus requires maintenance, subject to vandalism and theft, false counts from wildlife and e.g. gate swinging, no date or time reference	
Pressure and seismic vibration counts (e.g. pressure pad, sensor cable etc.)	Easy to conceal, requires little staff time, low power use, time and date references provided	Sensitive to false counts from e.g. wildlife and soil compaction, limited battery life, requires sensitivity calibration, dependent on electronic functioning	Cessford, Cockburn, and Douglas (2002) Melville and Ruohonen (2004)
Optical counts (e.g. infra-red)	Small, accurate, long-range, time and date references provided, low power use	Expensive, hard to conceal, subject to vandalism and theft, subject to false counts from e.g. wildlife and vegetation, lenses may be obscured	Arnberger, Brandenburg, and Muhar (2002) Cope and Doxford (1997) Hashimoto et al. (1997) Krämer and Roth (2002)
Magnetic sensing	Small, easily concealed, time and date references provided, can record vehicles	Does not detect non-metallic objects (e.g. people)	Visschedijk and Henkens (2002)

Microwave sensing	Small, time and date references provided, can detect both vehicles and people	Hard to conceal, can easily be obstructed, high power use, expensive equipment	

4.1.3 Chapter Plan

This study considers the use of modified camera-traps with inbuilt infrared sensors (henceforth referred to as infrared cameras) as visitor recorders. Most published literature concerning these decides relates to wildlife monitoring (e.g. Fouché et al., 2020; Green et al., 2020; Newey et al., 2015; Trolliet et al., 2014). Images and videos captured by infrared cameras can however, accurately provide information on visitor numbers, including group size, direction and mode of travel, duration of visit, and time and date of visit (Cessford and Muhar, 2003). These devices can also identify triggers of wildlife and vegetation, and therefore can be used to calibrate other recording types (e.g. standard infra-red counts; Cessford and Muhar, 2003). Infrared cameras are widely available at a relatively low cost, easy to use (Newey et al., 2015), and economically more efficient than alternative methods when utilised over long time scales (Roberts, 2011). Little evidence currently exists regarding the use of infrared cameras as nature-based tourism (NBT) visitor recorders, especially within GB, despite their obvious potential (Fairfax, Dowling, and Neldner, 2014).

Here, the potential for infrared cameras to be used within British PAs and RAs to record visitor numbers is explored. Modified versions of such devices were deployed between April 2019 and March 2020, to explore the seasonality of tourism visitation to areas across GB. Estimated annual visitor numbers were calculated and compared to numbers inferred by other means across a subset of sampled sites. Insight into the costs and benefits of infrared cameras as visitor recorders will be given.

4.2 Methods

4.2.1 Fieldwork

Thirty infrared cameras (28 Browning Strike Force Pro HD cameras and two Browning Recon Force Edge, hereafter referred to as Strike Force and Recon Force, respectively) were deployed across 27 British PAs and RAs (Table 4.2; Fig. 4.1) in late April - early May 2019. Sites were selected to incorporate a mixture of NBT characteristics, and hence comprised a range of different habitat types, sizes, staffing levels and infrastructure. Destinations were also chosen based upon geographic location, to represent varying remoteness and accessibility. No sites in Cornwall, Devon, Wales or north west Scotland were selected due to the time and cost limitations, particularly the travel time necessary for servicing etc.

Most sites had multiple access points. Therefore, a camera was placed at the most utilised access point of each site, generally located close to car parks, trails and roads (Beeco and Brown, 2013; Hadwen, Hill, and Pickering, 2007), as identified by site managers. At three of the largest, busiest sites with disjoint reserve sections or with more than one main access point, two cameras were deployed per site. At Leighton Moss, one camera (C1) was placed near the visitor centre, and a second (C2) at Morecambe Bay pools. At Saltholme, one camera (C12) was placed near the visitor centre, and a second (C13) on a pathway where people can access the site without paying and out of hours. At Minsmere, one camera (C18) was placed near the visitor centre, and a second (C19) at the main entrance to a separately accessible woodland section of the reserve. Each camera was housed within a sealed, camouflaged unit and positioned away from public view, approximately three metres high, secured by a locking mechanism to reduce the likelihood of vandalism or theft. Each unit was directed towards the main track entering each site, to gain greatest exposure and thus time, to capture each visitor, without interference from wildlife or vegetation.

TABLE 4.2: Information regarding the location, site owner, and primary habitat type where each infrared camera was set up to record visitors. The key codes indicate the position of the cameras on Fig. 4.1.

Site	**Key/ID relating to Fig. 4.1**	**Region**	**Owner**	**On-site staff**	**Primary habitat type**
Leighton Moss and Morecambe Bay (2)	C1/2	North West	RSPB	Yes (C1) and no (C2)	Wetland
Gait Barrows	C3	North West	NE	No	Limestone pavement
Caerlaverock	C4	Scotland	SNH	No	Wetland
Kirkconnell Flow	C5	Scotland	SNH	No	Raised Bog
Cairnsmore of Fleet	C6	Scotland	SNH	Yes	Upland
Glasdrum Wood	C7	Scotland	SNH	No	Oakwood
Loch Garten	C8	Scotland	RSPB	Yes	Pine forest
Insh Marshes	C9	Scotland	RSPB	No	Wetland
Rainton Meadows	C10	North East	WT	Yes	Wetland
Low Barns	C11	North East	WT	Yes	Wetland
Saltholme (2)	C12/13	North East	RSPB	Yes	Wetland
Blacktoft Sands	C14	Yorkshire	RSPB	Yes	Wetland
Frampton Marsh	C15	East Midlands	RSPB	Yes	Wetland
Titchwell Marsh	C16	East of England	RSPB	Yes	Wetland
Strumpshaw Fen	C17	East of England	RSPB	Yes	Wetland
Minsmere (2)	C18/19	East of England	RSPB	Yes (C18) and no (C19)	Wetland (C18) and woodland (C19)

Weeting Heath	C20	East of England	WT	Yes	Heathland
Lakenheath Fen	C21	East of England	RSPB	Yes	Wetland
Fowlmere	C22	South East	RSPB	No	Wetland
Denge Wood	C23	South East	FE	No	Woodland
Pulborough Brooks	C24	South East	RSPB	Yes	Grassland
Aston Rowant	C25	South East	NE	No	Grassland
Arne	C26	South East	RSPB	Yes	Heathland
Collard Hill	C27	South West	NT	No	Grassland
Ham Wall	C28	South West	RSPB	Yes	Wetland
Nagshead	C29	South West	RSPB	No	Woodland
Highnam Woods	C30	South West	RSPB	No	Woodland

Each camera was set up to take three multi-shot images, each two seconds apart, when the device was triggered. This occurs when the infrared sensor detects a moving object warmer than ambient temperature (Fairfax, Dowling, and Neldner, 2014). The trigger speed differed between the two camera types (Strike Force 0.15 seconds, Recon Force 0.4 seconds). This was highly unlikely to impact upon the likelihood of recording human visitors. A capture-delay of 10 seconds between shot-bursts was set to reduce the likelihood of repeatedly counting slow or standing visitors and to increase battery life. Different approaches to permit counts of individuals without potentially acquiring Personally Identifiable Information (PII) were trialled, and consequently, each camera lens was covered with opaque (brown parcel) tape to blur and darken the images. Each Strike Force and Recon Force was fitted with six and eight lithium-ion batteries, respectively, as well as a 128GB SanDisk Secure Digital eXtended Capacity (SDXC) card, expected to hold up to 72,000 images each. Each unit was motion tested before the time and date were digitally set and standardised across units. Cameras were programmed to function 24 hours per day.

Site staff and volunteers were asked to regularly check the presence, functioning and battery life of each infrared camera located within their site, though levels of engagement varied across sites. Throughout August and September 2019, SDXC cards were collected and returned to Durham where images were downloaded to extract non-identifiable data regarding the presence of people, time, and date. Where sufficient checks were taking place, the infrared cameras were left in place with new SDXC cards and batteries until collection in March 2020.

Due to the Covid-19 outbreak, cameras C12-15, C17, C21-22, C24 and C29-30 are, at the time of writing, *in situ*, holding information regarding tourism visitation from September 2019 onward. Cameras checked directly before the UK “lockdown” (March 23rd, 2020)

FIGURE 4.1: The location of each infrared camera (C1-30) set up to record visitors.

(C1, C3-9 and C11) were also left in place to record data which could provide insight into area usage during the pandemic. Two cameras (C2 and C25) were stolen between April 2019 and September 2019. Using tape to cover lenses resulted in both earwigs and caterpillar sheltering in the void at some sites (e.g. C5, C14 and C16), which distorted some images. One camera (C11) malfunctioned because of moisture infiltration, probably due to a faulty seal.

4.2.2 Data Interpretation

For each camera, image files were extracted from the SDXC cards and stored on a secure Durham University computer. Data regarding the number of days each camera was active, and the number of images taken throughout this period were extracted.

Due to time constraints, only images captured during the first full day of each month, per camera, were viewed.

First, the number of people on site during the first full day of each month was calculated by recording all visitors captured by the camera and divided by two (visitors are assumed to enter and exit along the same path, but not all visitors will be captured both entering and exiting). As three shots were taken each time the camera was triggered, a visitor was only counted once per set of three images (outlines of discrete individuals and, for example, dogs or bikes, could be identified from the darkened and blurred images, despite individuals being non-identifiable from a GDPR viewpoint). The total number of visitors recorded during the first full day was divided by the number of images taken on the first full day. This value was then multiplied by the total number of images taken across the month during full active camera days and divided by the number of full active camera days during the month to calculate a mean daily visitor number, per month, per camera. Second, to estimate the monthly visitor numbers, the mean daily visitor number per month was multiplied by the number of days within the specified month. Data for the first full day of each month can be found in Appendix A section A.2. Third, to crudely estimate the annual visitor numbers, an average monthly visitor number was taken across all months the camera was active and multiplied by 12. More precise estimates could be calculated given more time and collection of the cameras which hold data regarding winter tourism visitation, as visitor numbers are thought to fluctuate between the seasons.

No calibration using field observations were carried out due to the lack of time, funding and equipment. Therefore, to gauge the effectiveness of the infrared cameras as visitor monitors, the estimated annual visitor numbers for each camera were compared to estimated annual visitor numbers for each site collected in Chapter 3.

4.3 Results

3,109 full 24-hour days were surveyed in total, generating 861,129 images (Table 4.3). The Strike Force infrared cameras were incompatible with the high capacity 128 GB SDXC cards, only storing up to approximately 30-40% of their capacity, reflected by the short monitoring periods at some sites where the trigger frequency was high (e.g. C12, C16, C18, C21, C26). The visitor numbers for C12-13 and C18-19 could not be combined as multiple users could have been captured by both cameras and no PII was collected to discern this.

TABLE 4.3: The number of full (24 hour) active days for which each camera operated along with the total number of images taken during this period. Cameras C2 and C25 were stolen; no visitor data were recorded.

Site (ID)	**Number of days active**	**Total number of images**
Leighton Moss (C1)	107	54,742
Gait Barrows (C3)	146	13,726
Caerlaverock (C4)	155	33,781
Kirkconnell Flow (C5)	198	52,359
Cairnsmore of Fleet (C6)	230	52,350
Glasdrum Wood (C7)	338	18,114
Loch Garten (C8)	143	38,570
Insh Marshes (C9)	222	27,693
Rainton Meadows (C10)	85	57,428
Low Barns (C11)	98	23,533
Saltholme (C12)	43	24,717
Saltholme (C13)	70	27,142
Blacktoft Sands (C14)	30	30,844
Frampton Marsh (C15)	100	39,939
Titchwell Marsh (C16)	21	27,678
Strumpshaw Fen (C17)	134	44,662
Minsmere (C18)	30	27,417
Minsmere (C19)	88	27,537
Weeting Heath (C20)	47	27,864
Lakenheath Fen (C21)	21	27,982
Fowlmere (C22)	71	27,765
Denge Wood (C23)	138	11,676
Pulborough Brooks (C24)	133	26,201
Arne (C26)	27	27,462
Collard Hill (C27)	138	11,086
Ham Wall (C28)	40	27,350
Nagshead (C29)	168	24,091
Highnam Woods (C30)	88	27,384

The mean daily visitor numbers were calculated for all months that each camera was active (Table 4.4), showing that use-levels varied greatly between destinations. Only one camera (C7) recorded visitor numbers throughout all months of the year (Fig. 4.2), therefore little insight could be gained regarding the seasonality of tourism visitation. In the future, when cameras can be collected, data regarding seasonality will be extracted and incorporated to estimate more accurate annual visitor estimates.

TABLE 4.4: The mean daily visitor numbers estimated for each site for each month that data were available. Cameras C2 and C25 were stolen, therefore no visitor data were recorded.

Site (ID)	**Mean daily visitor number per month**											
	Apr-19	**May-19**	**Jun-19**	**Jul-19**	**Aug-19**	**Sep-19**	**Oct-19**	**Nov-19**	**Dec-19**	**Jan-20**	**Feb-20**	**Mar-20**
Leighton Moss (C1)	183.81	108.58				121.78	121.43					
Gait Barrows (C3)	25.51	25.17	31.64	24.28	27.22	16.13						
Caerlaverock (C4)	68.39	63.09				50.24	58.50	26.42	31.99			
Kirkconnel Flow (C5)	84.93	78.03					16.86	16.25	19.60	15.43	11.30	12.85
Cairnsmore of Fleet (C6)	134.55	49.91				5.45	6.91	12.64	8.03	14.35	13.55	17.93
Glasdrum Wood (C7)	23.52	26.45	19.72	18.61	11.37	11.02	15.06	5.24	4.85	2.82	4.39	2.02
Loch Garten (C8)	149.01	149.52	59.97			59.02	65.26	32.48	11.90			
Insh Marshes (C9)	51.38	52.19	52.21	38.73	34.71	54.44	30.97	18.82				
Rainton Meadows (C10)	83.06	49.17	97.98	239.60	288.60							
Low Barns (C11)	65.88	79.90	113.43				47.32	52.98				
Saltholme (C12)	290.27	136.18										
Saltholme (C13)	23.16	34.59	112.37									
Blacktoft Sands (C14)		124.72		106.90								
Frampton Marsh (C15)		104.61	143.31	29.90	111.14							
Titchwell Marsh (C16)		327.26										
Strumpshaw Fen (C17)		68.05	129.24	66.12	81.41	76.60						
Minsmere (C18)		265.17	118.00									
Minsmere (C19)		100.39	76.80	14.96								
Weeting Heath (C20)		37.24	30.39									
Lakenheath Fen (C21)		43.62										
Fowlmere (C22)		84.41	81.82	48.23								

Denge Wood (C23)		40.35	32.03	15.00	24.41	19.05						
Pulborough Brooks (C24)		74.70	79.41	78.22	62.20							
Arne (C26)	173.00	230.57										
Collard Hill (C27)	14.00	12.04	31.15	24.47	16.07	18.42						
Ham Wall (C28)	262.00	191.89	127.61									
Nagshead (C29)	48.99	32.28	42.02	41.78	36.48	32.95						
Highnam Woods (C30)	20.00	37.54	40.57	12.83								

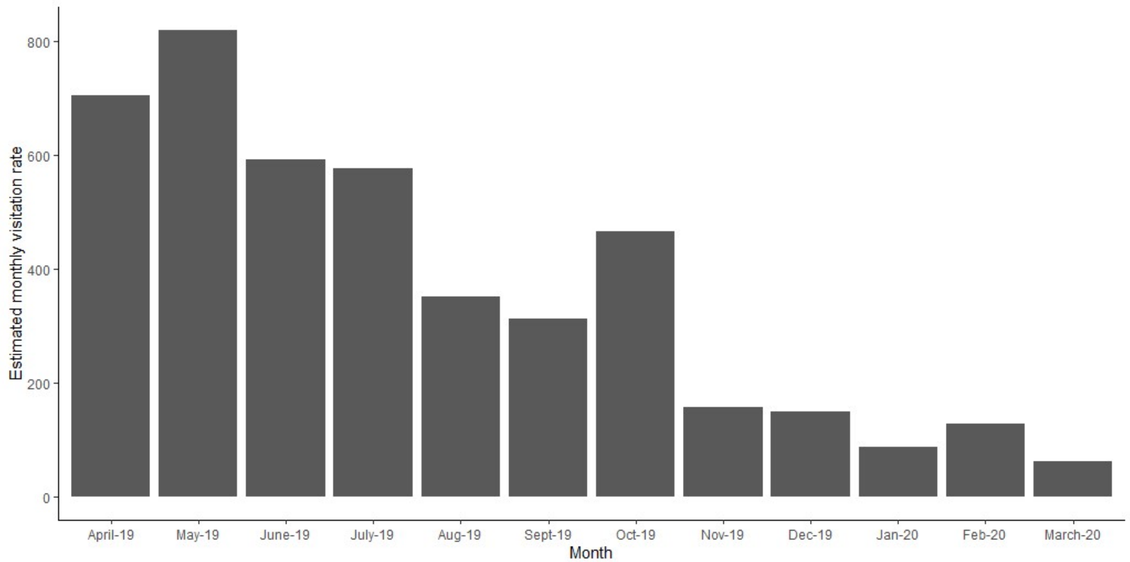

FIGURE 4.2: The monthly visitor numbers estimated for Glasdrum Wood (C7) from the deployment date in April 2019 to the second servicing date in Marsh 2020. Peak tourism periods can be identified in late spring - early summer and October.

Table 4.5 shows the annual visitor numbers estimated for each site from the infrared cameras as well as annual visitor number data gathered from personal contacts or literature in Chapter 3.

TABLE 4.5: The annual visitor numbers estimated from the infrared cameras and the annual visitor numbers sourced for each site. Cameras C2 and C25 were stolen therefore no visitor data were collected. (*) indicates data given in confidence.

Site (ID)	Estimated visitors from camera	Recorded visitors
Leighton Moss (C1)	48,895	78,595
Gait Barrows (C3)	9,151	*
Caerlaverock (C4)	18,224	*
Kirkconnel Flow (C5)	11,684	N/A
Cairnsmore of Fleet (C6)	10,644	*
Glasdrum Wood (C7)	4429	*
Loch Garten (C8)	27,499	*
Insh Marshes (C9)	15,241	N/A
Rainton Meadows (C10)	55,992	N/A
Low Barns (C11)	26,192	N/A
Saltholme (C12)	77,597	*
Saltholme (C13)	20,553	N/A
Blacktoft Sands (C14)	43,082	21,911
Frampton marsh (C15)	35,743	*
Titchwell Marsh (C16)	121,740	*
Strumpshaw Fen (C17)	30,860	*
Minsmere (C18)	70,562	*
Minsmere (C19)	23,520	N/A
Weeting Heath (C20)	12,396	N/A
Lakenheath Fen (C21)	16,228	N/A
Fowlmere (C22)	26,266	22,861
Denge Wood (C23)	9,612	N/A
Pulborough Brooks (C24)	27,153	68,107
Arne (C26)	74,026	44,197
Collard Hill (C26)	7,074	N/A
Ham Wall (C27)	70,547	N/A
Nagshead (C28)	14,292	13,751
Highnam Woods (C30)	10,136	N/A

A strong positive correlation was found between the annual visitor numbers estimated from the infrared cameras and the annual visitor numbers sourced (Linear Regression; $F_{1,14}$ = 35.23, $p <$ 0.0001, Adjusted R^2 = 0.6950), suggesting that infrared cameras could be used to monitor visitors in PAs and RAs, especially where visitor registration is not compulsory (Fig. 4.3).

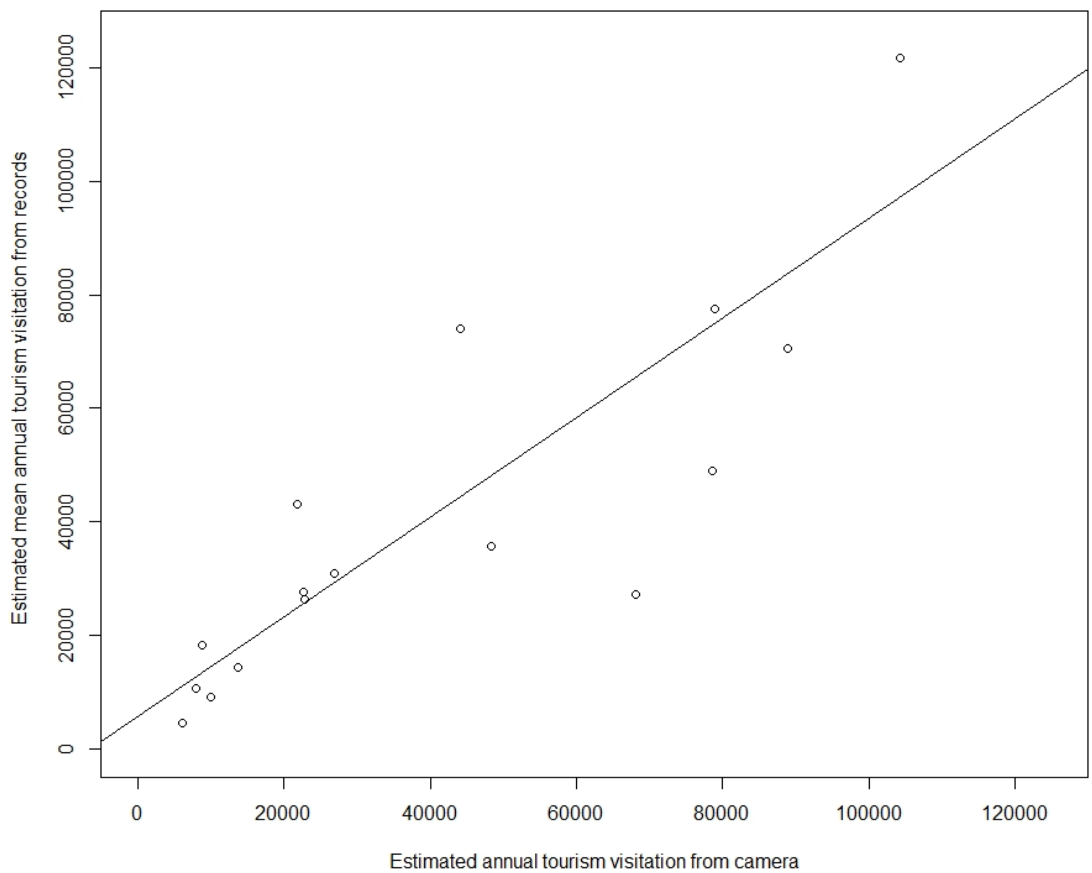

FIGURE 4.3: The relationship between the annual visitor numbers estimated using the infrared cameras and the visitor numbers sourced for each site. Linear regression line shown ($y = 0.8773x + 5663$).

4.4 Discussion

This study shows that the use of infrared cameras as visitor monitors, within British PAs and RAs, is feasible and could be used on a local, regional or national scale. The similarity between the visitor numbers estimated in this study and the visitor numbers sourced by alternative means suggests that cameras could also be used to calibrate alternative visitor monitoring equipment, given that time and resources are available. This data could also be incorporated into, or used to validate, linear regression models (e.g. Ploner and Brandenburg, 2003), such as those developed in Chapters 2 and 3.

This methodology could be adopted by site managers, especially where visitor registration or payment is not compulsory (e.g. C4, C5, C6, C7), and where on-site staff are not present all year round (e.g. C8 and C20), to provide information regarding changes in visitor numbers. For example, cameras provided data on visitor use in sections of reserves where tourism flow is not monitored and where visitors are not required to register or pay (e.g. C19, C24). This data can assist site managers in making informed and strategic decisions, especially in relation to changes in marketing approaches (Reynolds and Elson, 1996).

The hourly, daily and monthly data which can be extracted from infrared cameras can also be used to identify peak tourism periods, where additional staffing levels may be beneficial. This is particularly important for areas with no on-site staff. During peak tourism periods, staff could be required to control excess traffic and regulate parking (e.g. C2, C3, C19, C30), prevent inappropriate behaviour such as littering and vandalism (e.g. C22), or oversee facilities such as toilets or campsites (e.g. C4). Similarly, infrastructure developments or school group trips could be planned for periods of low use.

Understanding tourism seasonality could also provide insight into the motivations of nature-based (NB) tourists to visit sites. Data regarding the emergence, arrival and departure of flora and fauna could shed light on how key wildlife events coincide with tourism periods. Such data could be provided by site managers or collected from tourism resources or wildlife handbooks. For example, visitation data from Glasdrum Wood (C7) suggests that tourism peaks in late spring - early summer, with a second peak in October, the former of which coincides with the emergence of flowers and butterflies, including the nationally rare chequered skipper, *Carterocephalus palaemon* (Scottish Natural Heritage, 2016). Similarly, continual visitor data (rather than data only collected when visitor centres are open) for Loch Garten (C8) and Weeting Heath (C20) would validate whether tourism peaks coincide with the breeding seasons of ospreys, *Pandion haliaetus*, and stone curlews, *Burhinus oedicnemus*, respectively.

Furthermore, these infrared cameras can provide information on, for example, out of hours access to sites once visitor centres are closed. In relation to the Covid-19 pandemic, cameras that have been left running will be able to provide data to assess the degree to which lock-down and reserve closure policies have been flaunted. Moreover, as birds and mammals trigger the infrared cameras and are distinguishable from human visitors, their utilisation of public footpaths, as identified by cameras, would prove an interesting comparison of reduced visitors during the Covid-19 lock-down period.

Images taken could be used to potentially identify different user groups (e.g. Arnberger, Haider, and Brandenburg, 2005; Fairfax, Dowling, and Neldner, 2014), such as dog walkers (e.g. Arnberger and Hinterberger, 2003), cyclists and family groups. This would be especially beneficial for sites which are not purely promoted on a wildlife-tourism basis, Collard Hill (C27, popular with cyclists), Kirkconnell Flow (C5, popular with dog walkers), and Denge Wood (C23, popular for horse-riding). This method can also be used to recognise controversial behaviour, such as overnight parking of motorhomes at Cairnsmore of Fleet (C6) and wild-fowling or poaching at Caerlaverock (C4). This would provide further details regarding the motivation behind tourism visitation and the extent to which wildlife is exploited as a cultural ecosystem service. Moreover, long-term use of infrared cameras would allow comparison of annual changes in visitor flow which may prove beneficial for site managers.

Throughout this pilot study, limitations associated with infrared camera usage became apparent, suggesting further calibration and servicing would be beneficial.

First, it must be stressed that the annual visitor numbers calculated in this study are only estimates. Collection of the cameras which hold information from September onward, along with more time, is required to produce more accurate estimates of visitor numbers. This data would also provide insight into how visitation differs throughout the year, as it is expected that some sites may be most popular during the summer (e.g. C8 and C20), and others during the winter (e.g. C4 and C16). Additionally, it would prove beneficial to assess differences between weekdays and weekends, and to look at the effect of public holidays and school holidays on camera trigger frequency. This data could also be incorporated to estimate more accurate visitor numbers.

The availability of staff, funding and time must be considered when developing any visitor counting system (Cessford and Muhar, 2003). Funding is required for the infrared camera units, SDXC cards, batteries, and locking devices, as well as the costs of servicing (staff and travel costs). Time is required to deploy the units, regularly check and update the SDXC cards and batteries, and to view images taken to calculate visitor numbers. The time and costs associated with data interpretation could be reduced through the development of image recognition software (Arnberger, Haider, and Brandenburg, 2005).

Interestingly, both the Strike Force and Recon Force cameras claim to support use of a 512GB SDXC card (NatureSpy, 2019). This, however, appeared not to be the case, and only approximately 48GB, on average, of potential 128GB storage was utilised by the Strike Force cameras, preventing the collection of visitor data throughout all months at some busy sites, where it was anticipated that SDXC capacities would last much longer. When utilising infrared cameras as visitor recorders at heavily utilised sites, it could be recommended that SDXC cards be changed more frequently. For example, Arne (C26) could be serviced every 27 days (see Table 4.3). Alternatively, Recon Force cameras could be deployed to sites of high tourist use, rather than Strike Force. Additionally, an alternative substance (e.g. petroleum jelly), could be used in preference to the tape used to blur the camera lens and reduce the likelihood of insects sheltering in the void and distorting the images. Alternatively, lens filters could be created for visitor monitoring purposes, or camera units could be placed within a concealed box with opaque "window", the latter of which would further reduce the vulnerability of the devices to theft or vandalism (Olsson, Widén, and Larkin, 2008), and would prevent moisture infiltration.

Many triggers were the result of additional environmental factors, especially the growth and movement of vegetation in the wind (e.g. C4, C6, C10 and C21), a limitation outlined by previous studies (Fairfax, Dowling, and Neldner, 2014; Towerton et al., 2008). This included movement of the trees in which cameras were positioned, necessitated by the need to conceal cameras from the public view. Only images from the first full day of each month were viewed and may not have held a representative sample of the environmental triggers throughout the month. Therefore, observation of more days, and particularly days with anomalously high image counts, would provide a more accurate estimate of daily visitor flow.

Additionally, many triggers may have been a result of staff movement on-site (e.g. C8, C10-C11) and contractor services (e.g. C17) potentially leading to inaccurate estimates of annual tourism visitation. Errors may have also resulted from the placement of units on-site. Each camera was positioned with guidance from site staff, yet inaccurate visitor numbers may have resulted from multiple triggers from the same individuals, especially those milling about vehicles (e.g. C6), picnic benches (e.g. C7), and parking ticket machines (e.g. C26), suggesting that these cameras could be better placed where visitors are channelled into the site, or where lenses could be angled further downwards. It is strongly recommended that calibration exercises be carried out for each site through direct observations or video monitoring (Arnberger, Haider, and Brandenburg, 2005; Cessford and Muhar, 2003). This would allow calculation of the ratio of visitors which are captured or missed by the cameras, assessing their operational accuracy (Melville and Ruohonen, 2004). This is dependent on the availability of staff, time and funding.

4.5 Conclusion

Modified wildlife cameras with inbuilt infrared sensors can feasibly be used to record visitor numbers within PAs and RAs, especially destinations without on-site staff or alternative recording devices in use. Several sources of error outlined in the discussion section could be, and should be, resolved for the method to work. If cameras are utilised as visitor recorders, their results could provide insight into what motivates tourists to visit a site (e.g. wildlife, cycle routes, wildfowling) and how this changes over time. This data, along with the drivers of NBT and recreation, is required to sufficiently outline management implications for sites, as discussed in Chapter 5.

Chapter 5

Implications for Protected Area Management

As discussed in Chapter 1, to manage tourism sustainably and responsibly, the tourist's decision process to participate in nature-based tourism (NBT) must be understood (Eagles, Mccool, and Haynes, 2002). Decision processes are influenced by personal attitudes towards performing specific behaviours, subjective norms, and perceived behavioural control (Ajzen, 1988). Chapters 2 and 3 have identified and discussed some of the drivers of tourist behaviour, and Chapter 4 has explored a methodology which can be used to identify user types and behaviours. The results have allowed methods of controlling visitor behaviour and negative impacts of tourism to be recognised and will be discussed in this chapter, with reference to "*demarketing*" (Eagles, Mccool, and Haynes, 2002). *Demarketing* is defined here as "a proactive tool for managing visitor demand by influencing, redistributing, and in specific cases, reducing demand" (Armstrong and Kern, 2011). Here, the "4 Ps" of the *demarketing* approach: "product", "place", "price" and "promotion" (Kotler and Levy, 1971), are sought to manage NBT within protected areas (PAs) with reference to this study's findings.

These flexible *demarketing* techniques have been applied to PAs with excess tourism demand (Armstrong and Kern, 2011; Groff, 1998; Ferreira and Harmse, 1999) in order to deflect tourism pressure towards under-utilised sites (Medway and Warnaby, 2008; Medway, Warnaby, and Dharni, 2011). Thus, *demarketing* does not aim to reduce tourism visitation, but aims to control visitor flow, generating an equilibrium between visitor pressure and expectations, economic revenue, and sustainable conservation management (Armstrong and Kern, 2011; Beeton and Benfield, 2002). Under-utilised sites can also adopt the inverse of these techniques to increase their tourism potential, further benefiting local communities and conservation initiatives.

The promotional marketing technique has been the general concern of previous research (Armstrong and Kern, 2011), however, the "4 Ps" are not mutually exclusive, but should be used appropriately with regards to equity and access (especially "place" and "price", Kotler and Levy, 1971). Improper imposition of the "4 Ps" can threaten the economic viability of PAs, and likewise the ability of PAs to recover from shifts in global or regional tourism demand (e.g. during the current Covid-19 crisis) may be dependent on the state of these strategies (Beeton and Benfield, 2002). These approaches are also reliant on stakeholder intentions, staff, funds, equipment, infrastructure, and access to information, as outlined by the IUCN guidelines on management effectiveness (Hockings, Leverington, and James, 2006). Stakeholders, such as conservation organisations, researchers, and PA managers could also engage with local communities to increase their awareness of their threats towards biodiversity and increase their support for the PA network, rendering the sustainable development of PAs and NBT a multidisciplinary approach (Blackstock et al., 2008; MacLellan, 1999; Myers, 1972; Rotherham, Doncaster, and Egan, 2005).

Marketing techniques can be implemented proactively prior to, or reactively once, the social or environmental carrying capacities of a PA have been reached (Beeton and Benfield, 2002). Knowledge of tourism drivers and PA social and environmental carrying capacities is required to define suitable management implications (Beeton and Benfield, 2002; Blackstock et al., 2008; Eagles, 2014; Ferreira and Harmse, 2014; MacLellan, 1999; Medway, Warnaby, and Dharni, 2011; Sime, Crabtree, and Crabtree, 1991). This study has identified the drivers of tourism across Africa and Great Britain (GB), however, visitation data is patchy and the carrying capacities of each site are unknown, therefore examples of specific implications should only be viewed lightly.

5.1 Product

Managing the content or quality of the NBT product within PAs can influence the attitudes and intentions of an individual to visit (Ajzen, 1988; Kotler and Levy, 1971).

5.1.1 The Wildlife-based Product

The quality of the wildlife-based (WB) product could be enhanced by increasing the availability or observation ease of species known to appeal to tourists, for example those which possess appealing traits as defined by Chapters 2 and 3. The availability of species can be accomplished through, for example, introductions of popular species or increased densities of popular species. Enhancing the observation ease can be accomplished through, for example, creating water-points and viewpoints. Alternatively, where visitor pressure is presumed to be very high, a reduced availability or observation ease of popular species or increased availability or observation ease of less popular species could direct visitor pressure away from a site, or potentially attract specialist tourists which are thought to be more environmentally friendly (Buckley, 2013; Di Minin et al., 2013; Hausmann et al., 2017a; Lindsey et al., 2007; Reynolds and Braithwaite, 2001).

Despite the associated detrimental impacts on indigenous species, there is evidence of popular extralimital species introductions and increased densities of popular species within sites, with the goal of enhancing the appeal of the site to tourists (Maciejewski and Kerley, 2014b; Maciejewski and Kerley, 2014a; Parker and Bernard, 2005). For example, increased African elephant, *Loxodonta africana*, densities can result in the demise of wider biodiversity (Blignaut, Wit, and Barnes, 2008; Maciejewski and Kerley, 2014a; Van Aarde, Whyte, and Pimm, 1999), such as the destruction of baobab trees, *Adansonia* sp. (Myers, 1972). Increased elephant densities can however contribute to the rarity of, for example, the Maasai giraffe, *Giraffa camelopardalis tippelskirchi*, which in turn, enhances its tourism appeal (e.g. Amboseli National Park (NP), Okello, Manka, and D'Amour, 2008). Increasing the availability of species which are threatened can, however, be seen as a success from a conservation viewpoint (e.g. hazel dormouse, *Muscardinus avellanarius*, Morris, 2003).

The results of Chapter 3 suggest that reduced control over game (e.g. brown hare, red deer) and predator (e.g. stoat) mammal species would enhance the appeal of British PAs to WB tourists. This management would, however, pose a threat towards conservation initiatives, especially those associated with ground-nesting birds. Similarly, "game cropping" has been used as a form of managing species populations, especially those in excess, typically within confined electrified boundaries (Aylward and Lutz, 2003; Di Minin et al., 2013). Artificial control may, however, limit achievable population sizes (Stephens, 2015) and be regarded as "interference" with nature (Myers, 1972). Such direct management over species has lead to conflict over "conservation for [eco]tourism, rather than [eco]tourism for conservation" (Di Minin et al., 2013).

Secondly, enhancing the viewing ease of popular species could allow the development of memorable wildlife experiences and therefore attract tourism. For example, artificial water points could be created within an ecosystem management approach, which considers the bottom-up and top-down effects between component species (Ripple et al., 2014; Shorrocks and Bates, 2015) to increase species local availability and therefore, viewing ease. Without careful consideration of species interactions, population crashes may arise from increased species concentrations, such as those recorded in Kruger NP during the 1990s (Harrington et al., 2014; Mills and Funstonm, 2003). Viewing ease can also be improved through the creation of viewpoints, hides and nest cameras (Armstrong and Kern, 2011; Dickie, Hughes, and Esteban, 2006; Orams, 1996a), whilst contributing to the "sense of place" experience, so long as such areas are not overcrowded (Barendse et al., 2016; Hausmann et al., 2017a; Hausmann et al., 2017b).

As reducing the availability of wildlife to reduce tourism pressure in over-utilised sites is unfavourable as this contradicts the purpose of PA designation (King et al., 2012), reducing the viewing ease of species in such areas is thought to be preferential. For example, sections of PAs, such as those hosting appealing but sensitive species, or overcrowded observation areas (Curtin, 2010; Grünewald, Schleuning, and Böhning-Gaese, 2016; Turpie and Joubert, 2001), could be closed off from tourism with the use of physical barriers, boardwalks, and poorly maintained footpaths (Armstrong and Kern, 2011; Beeton and Benfield, 2002; Orams, 1996a).

Activities within PAs which may have detrimental impacts on wildlife or visitor experiences could also be restricted to certain areas or times (Reynolds and Braithwaite, 2001).

For example, night drives in African NPs could be restricted to a 10km radius of each camp to reduce the likelihood of speeding and collisions. Alternatively, activities could be prohibited unless overseen by qualified commercial partners or park staff (Armstrong and Kern, 2011), ensuring a "sense of security" to "sense of place" (Hausmann et al., 2017a; Hausmann et al., 2017b; Russell et al., 2013; Stedman, 2003). To attract tourism, these activities could be expedited in African NPs with less dangerous game without supervision, (De Vos et al., 2016) such as Mt Elgon NP and Kilimanjaro NP, or within British PAs such as Noss (e.g. kayaking).

When managing the WB product, it is important to consider the attitudes of local people (Mamo, 2015). Akin to flagship campaigns, increasing the availability of target species may be locally inappropriate (Di Minin et al., 2013; Linnell, Swenson, and Andersen, 2000; Mamo, 2015) and may lead to increased human-wildlife conflict (Roque De Pinho et al., 2014) and reduced support for conservation (Abukari and Mwalyosi, 2018; Meijaard and Sheil, 2008). Some suggest that this could be offset by allowing local people to participate in NBT (e.g. Roque De Pinho et al., 2014), which, typically in developing countries, could render the size of the local catchment population a potential future driver of tourism visitation.

Additionally, to reduce the pressure on the environment within PA boundaries, and subsequently promote the wildlife experience, it can be recommended that the land directly outside of the PA boundaries be managed as a buffer zone, preventing the development of detrimental infrastructure (Ferreira and Harmse, 2014; SANParks, 2011). This may, however, result in conflict with local communities which depend on the land and its resources. To reduce anthropogenic pressures on wildlife and PAs, and enhance the support for conservation, it is suggested that communities could be provided with, for example, alternative or improved livelihood activities (Abukari and Mwalyosi, 2018). The development of sustainable agricultural practices, for example, could instigate cooperation rather than competition between stakeholders (Chung, Dietz, and Liu, 2018; Foley et al., 2011; Myers, 1972). A change in Maasai behaviour away from traditional lion hunting (Abukari and Mwalyosi, 2018) in the Amboseli ecosystem can, for example, be attributed to the Maasai Olympics, where local people compete for recognition (BigLife Foundation, 2020). This intervention could be developed to incorporate Maasai warriors from Tanzania to additionally enhance international relations, or alternatively, attract wealthy tourists. Local communities can further be empowered through integration into PA management and tourism operations (Buckley, 2009), which can be seen as a prerequisite for NBT success, not just specifically for ecotourism as previously suggested (e.g. Child, 1996; Krüger, 2005; Lindsey et al., 2007; Wells, 1993).

Ultimately, it is clear that the management of wildlife within PAs should focus on cooperation with local communities, promotional approaches, and education on the importance of species conservation and its association with sustainable tourism, rather than artificially managing populations to feed the tourism demand (Beh and Bruyere, 2007; Di Minin et al., 2013; Goodwin and Leader-Williams, 2000; Grünewald, Schleuning, and

Böhning-Gaese, 2016; Lindsey et al., 2007; Okello, Manka, and D'Amour, 2008; Schänzel and McIntosh, 2000), unless to prevent the loss of species or reduce environmental degradation (Barnosky et al., 2011; Ceballos et al., 2015).

5.1.2 The Nature-based Product

Chapters 2 and 3 identified the additional features which can be managed in order to influence tourism visitation. The results suggest that underutilised sites could attract more tourists by enhancing their habitat diversity, and overutilised sites would deter tourists by reducing their habitat diversity, both of which require considerable management intervention. Other findings suggest that tourists favour natural landscapes and their associated habitats (Beh and Bruyere, 2007; Curtin, 2005; Fredrickson and Anderson, 1999; Grünewald, Schleuning, and Böhning-Gaese, 2016; Markwell, 2001; Okello, Manka, and D'Amour, 2008; Schänzel and McIntosh, 2000), which suggests that habitats within PAs should not be managed to attract tourists, and intensively managed to reduce visitor pressure. Moreover, tourist preferences for specific wildlife and landscape experiences are thought to change over time (Bryan, 1977; Duffus and Dearden, 1990), thus an adaptive approach towards habitat management should be prioritised. Therefore, similar to wildlife management, it could be recommended that habitats should not be managed based upon their tourism appeal but on a conservation basis, which may involve some stringent management (e.g. forestry, Jackson and Gaston, 2008). Akin to the above, management of sites with excess tourism demand could involve restricted access to specific habitat types or utilise an alternative "4 P" strategy. Similarly, to attract tourists to under-utilised sites, the nature-based (NB) experience could be enhanced through the provision of educational facilities, tour guides, viewpoints and additional NB activities (Armstrong and Kern, 2011; Orams, 1996a).

The findings of Chapter 2 show that the Human Development Index (HDI) of country in which a NP resides can influence tourism visitation. The dimensions of HDI (life expectancy, education and income), however, cannot be directly managed by NPs to control visitor numbers. Despite this, the cooperation between local communities, park management and regional stakeholders required for sustainable tourism can promote reconciliation and societal healing through "Culture of Peace" (Ackermann, 2003; Alluri, 2009; Brewer and Hayes, 2011; Causevic and Lynch, 2011; International Institute for Peace through Tourism, 2020; Novelli, Morgan, and Nibigira, 2012; Sullivan and Tifft, 2007). Consequently, socio-economic recovery through the development of tourism can assist in regional development (e.g. Rwanda, Alluri, 2009). This may, however, lead to the dependence of developing countries on international tourism, which may become unsustainable under global shifts in tourism demand (e.g. during the current Covid-19 crisis).

This study also found that tourism visitation is influenced by accessibility. The results suggest that, to gain greater interest from tourism, African NPs could be designated close to cities and GB PAs could be established in highly populated areas. This, however, may be unrealistic due to conflicting proposals between land conservation and land development initiatives, the latter of which has considerably larger funds and incentives supported by governments (Jackson and Gaston, 2008). The dependence of an expanding PA network on tourism visitation and funding can be highlighted by the tourism and conservation life-cycle (see Eagles, Mccool, and Haynes, 2002). Moreover, the habitats existing close to urbanised areas are typically fragmented due to land development and intensive agriculture, therefore despite their accessibility, they may host unviable populations of species which are difficult to conserve long-term and may also not appeal to tourists (Fahrig, 2003; Jackson and Gaston, 2008; Lasky and Keitt, 2013). Increasing the connectivity between sites may enhance species viability by reducing edge effects (Salvador, Clavero, and Leite Pitman, 2011; Woodroffe and Ginsberg, 1998). It can be suggested, however, that the focus of PA management could be on maintaining and altering the accessibility of the current PA network, rather than on creating new PAs on limited land of high economic value. Managing current accessibility is, however, associated with the time and expense necessary for the visitor to participate in NBT within the PA, rather than the PA product itself (Kotler and Levy, 1971). Such management implications regarding alternations in accessibility can be found in the "place" *demarketing* strategy section (see section 5.2).

Additional factors which are widely regarded to influence tourism visitation were discussed in Chapters 2 and 3, with regards to why there were differences between observed and predicted tourism visitation. Such factors are associated with the NB product and therefore could be considered when outlining management implications for sites, however, such factors could also be quantified for future analyses. For example, tourism visitation could be managed through the development of infrastructure and services (Duffus and Dearden, 1990), and the availability of, for example, affordable accommodation (Butler, 1985). When aiming to attract generalist tourists is may be beneficial for tourism management to increase facilities such as toilets, shops, and cafes, which could satisfy their "habitus" (Bourdieu, 1984; Greenway, 1995). The development of such facilities, however, may be limited by funding (Jackson and Gaston, 2008; Khadaroo and Seetanah, 2008; Wilkie and Carpenter, 1999a). Such growth of facilities and associated "Trojan Horse Effects (Pleumarom, 1993) may also place greater pressure on the environment (Duffus and Dearden, 1990), and if not controlled, could result in excess tourism demand, which could potentially require closure of such facilities to reduce tourism pressure and, in turn, would not be economically viable. Alternatively, if a site aimed to attract more specialist tourists or dissuade mass tourism, commercialisation could be kept to a minimum (Duffus and Dearden, 1990; Schänzel and McIntosh, 2000). It can also be suggested that on-site staff could be trained in tourism management as well as conservation in order to educate visitors about their potential impacts on the wildlife and wider communities. Staff could also act as tour leaders, aiming to modify the negative impacts and behaviours of tourists (Boren, Gemmell, and Barton, 2008; Curtin, 2010).

5.2 Place

Secondly, managing the time or expense necessary to participate in NBT within PAs could further affect the perceived behavioural control of an individual, and therefore their intention to visit (Ajzen, 1988; Kotler and Levy, 1971).

This "P" is best executed when there is significant knowledge of the current pressures on the WB product and the ecological carrying capacity, or visitor use threshold of a site (Ferreira and Harmse, 1999; Saveriades, 2000; Wagar, 1964). "Place" restrictions can be viewed as strict, and therefore are not commonly used (Hill and Pickering, 2002). Equity concerns may also arise when dealing with pricing and accessibility to private and public transportation (Beeton and Benfield, 2002; Blackstock et al., 2008; Eagles, 2014; Kendal, Ison, and Enoch, 2011; Kotler and Levy, 1971). The adoption of "place" restrictions may result in drastic shifts in tourism satisfaction (Akama and Kieti, 2003; Arbieu et al., 2018), especially if applied to international sites without lengthy notice. Therefore, they could be used in combination with promotional strategies to inform potential visitors of restrictions as well as alternative destinations to visit (Groff, 1998).

As mentioned in the "product" section (see section 5.1), accessibility was found to influence tourism visitation. To prevent over-utilisation of African NPs, travel time to cities could be increased. Likewise, increasing travel time and reducing accessibility for local people could reduce tourism pressure within British PAs, yet such implications may be limited by funding (Khadaroo and Seetanah, 2008; Wilkie and Carpenter, 1999a). Furthermore, incentives to travel to more remote destinations could assist in redistributing visitor pressure (Armstrong and Kern, 2011; Benfield, 2000; Groff, 1998). Most tourists travel by private vehicles either due to the lack of alternative transport options or because of habitual behaviour which is difficult to influence (Butler, 1985; Coulter et al., 2007; Lennon and Harris, 2020; Okello, Manka, and D'Amour, 2008; Stanford, 2014; Timothy, 2011). Therefore, restrictions against accessibility typically include road closures, traffic calming, route hierarchies (Orams, 1996a; Steiner and Bristow, 2000), and reduced road maintenance (e.g. Akama and Kieti, 2003). Such measures may be opposed by local people, potentially reducing their support for tourism management (Blackstock et al., 2008; Dickinson and Dickinson, 2006). Moreover, similar restrictions on arrival time and travel ease exist when travelling by ferry.

Alternatively, it can be proposed that travel time to underutilised sites could be reduced through enhanced road quality (Akama and Kieti, 2003; Ferreira and Harmse, 2014; Hausmann et al., 2017b) or by lifting restrictions. For example, the current dualling of the A9 from Perth to Inverness will increase tourism flow to the Highlands and Islands of Scotland. Similarly, increased accessibility to remote islands can result from improvements in ferry services (Butler, 1985), or improvements in private boat trip provision. Developments in public transport, cycling or pedestrian services, (e.g. the Speyside Way in the Cairngorms NP), could also increase the access of local people to PAs in GB (Steiner and Bristow, 2000). As mentioned in Chapter 1, the associated benefits of increased tourism in remote communities may however, be at the of the survival of wildlife (MacLellan, 1999). For example, increased accessibility can facilitate the movement of less environmentally-friendly tourists and even poachers (Chung, Dietz, and Liu, 2018; Daniel et al., 2012).

Once tourists have reached a site, additional "place" strategies can be established to manage visitors. For example, when tourists are required to enter a PA through a visitor centre or kiosk (e.g. many African NPs, RSPB reserves), restrictions can be put in place to limit the number of people entering a site to prevent overcrowding, and likewise restrictions can be lifted or eased to promote the appeal of sites under-utilised by tourists (Armstrong and Kern, 2011). Such restrictions include site closure (Orams, 1996a), "park full" strategies (e.g. Wilsons Promontory National Park, Beeton and Benfield, 2002), advance booking systems (e.g. Snowdon Mountain Railway, Kruger NP, Beeton and Benfield, 2002; Ferreira and Harmse, 2014), queuing (Wearing and Neil, 1999), timed entry systems (e.g. Sissinghurst Castle, Beeton and Benfield, 2002; Medway, Warnaby, and Dharni, 2011), entry quotas (e.g. Kruger NP, Ferreira and Harmse, 2014), limits on group sizes (e.g. passenger ferry to Noss, gorilla trekking groups, Butynski and Kalina, 1998; Nielsen and Spenceley, 2010). Loch Leven, for example, could limit the number of school groups hosted on site, and divert educational classes to less heavily utilised sites.

When visitors are not required to enter through a visitor centre (e.g. many open access GB PAs), "place" marketing techniques are typically less strict. For example, tourist numbers can be managed through changes in car parking provision (Steiner and Bristow, 2000), by which group sizes can also be controlled through the availability of coach or non-delineated bays as well as height restriction barriers. Reduced parking availability, however, can lead to the "shunting effect" (Kendal, Ison, and Enoch, 2011), where vehicles park on grass verges or footpaths outside of designated parking areas. This can contribute to erosion and cause hazards for pedestrians, but can be controlled through double yellow lines (Kendal, Ison, and Enoch, 2011), or rock barriers. Tourist numbers can also be managed through access points, for example, a "gateway approach" (Beunen, Regnerus, and Jaarsma, 2008) could be used to restrict visitor flow through specific entrances therefore limiting the negative impacts of tourism across the entire site. Alternatively, to increase the visitor flow through a site, such as Geltsdale and Glendue Fells, overflow car parking could be established. "Place" restrictions at open access sites can be more stringent (e.g. site closure) if there has been damage (e.g. vandalism), or if the wildlife is at risk (e.g. 2001 Foot and Mouth Outbreak, Medway, Warnaby, and Dharni, 2011). Site closure, however, generally requires behavioural input from visitors, and therefore visitors could be monitored with the use of infrared cameras and fines associated with rule-breaking could be imposed (Orams, 1996a).

5.3 Price

Thirdly, introducing or altering prices for tourists visiting PAs can have a strong influence on an individual's attitudes and intentions (Ajzen, 1988; Kotler and Levy, 1971)

Akin to "place", "price" implications can be more stringent when visitors are required to access through a visitor centre, or where staff patrol the site. For example, increased entrance fees, removal of discounted prices (e.g. Sissinghurst Castle, Beeton and Benfield, 2002) and the introduction of permits can deter people from visiting heavily utilised sites (Armstrong and Kern, 2011; Kotler and Levy, 1971; Orams, 1996a; Wearing and Neil, 1999). When visitors are not required to enter through a visitor centre, accommodation (e.g. African NPs), private tour-guide (e.g. British PAs, Kendal, Ison, and Enoch, 2011), ferry, and parking (Steiner and Bristow, 2000) charges could be increased to deter visitors. For example, visitor pressure at Studland and Godlingston Heath and Satlfleetby-Theddlethorpe could be reduced through raised car parking fees. Entrance fees could be implemented at Mugdock Country Park to reduce over-utilisation of Mugdock Wood. Increasing the price of the Snowdon Mountain Railway or removal of the "early bird" discount could also deter people from Yr Wyddfa. Alternatively, to increase the appeal of a site to visitors, and increase the likelihood of return visits, fees could be removed or lowered, and membership discounts could be generated.

Increasing the tourist fees associated with African NPs may reduce tourism pressure on the ecosystem whilst procuring revenue which can be redirected into park conservation (e.g. Amboseli NP, Okello, Manka, and D'Amour, 2008). Alterations in fees, however, raises equity concerns as higher income groups are target marketed (Beeton and Benfield, 2002; Blackstock et al., 2008; Eagles, 2014; Kendal, Ison, and Enoch, 2011; Kotler and Levy, 1971), and therefore the spectrum of income groups visiting the site could be recognised. For example, introducing or increasing entrance or accommodation fees within South African NPs could conflict with political pressure for ease of access (e.g. Ferreira and Harmse, 2014). Additionally, target marketing of higher income groups may result in selection against tourists which are typically interested in wider biodiversity and less popular species, which in turn may oppose conservation aims (Beeton and Benfield, 2002; Clements, 1989; Di Minin et al., 2013; Eagles, 2014; Kotler and Levy, 1971).

5.4 Promotion

Finally, promotional and educational information can be marketed to encourage or discourage people to participate in NBT within PAs by influencing personal attitudes, subjective norms and perceived behavioural control (Ajzen, 1988; Kotler and Levy, 1971; Orams, 1996a). Previous research suggests that information disseminated by websites, social media and television can influence the public's attitudes and intentions to partake in NBT (Armstrong and Kern, 2011; Boniface, 1999; Bulbeck, 2005; Colléony et al., 2017; Lew, 1991; Stanford, 2014; Wood et al., 2013; Zillinger, 2006).

Out of the "4 Ps", this "promotion" strategy is thought to have the most influence on creating and shifting tourism demand on both an annual and seasonal basis (Beeton and Benfield, 2002). For example, promotion of NBT and associated activities in the shoulder months could extend the tourism season, therefore benefiting local communities throughout the year (e.g. Orkney, Rayment and Dickie, 2001). Similarly, balancing the promotion of low season activities and peak season activities could balance out the annual tourism pressure (Beeton and Benfield, 2002). For example, tourism visitation to Yr Wyddfa could be balanced through greater promotion of winter activities and reduced promotion of e.g. the summer National Three Peaks Challenge. Promotional aspects of marketing, like "product", "place" and "price" should, however, consider the attitudes of local people towards site attractions (e.g. species, Meijaard and Sheil, 2008; Roque De Pinho et al., 2014) in order to enhance the support for the long term safeguarding of PAs (MacLellan, 1999).

5.4.1 Species Promotion

It can be suggested, in order to attract tourists to PAs, species found to be popular in the WBT resources consulted in this study could also be promoted through social media channels, websites and the like. Additionally, WB activities such as guided walks and night drives could be promoted to increase the appeal of sites which may be underutilised by tourists. Alternatively, sites which may have exceeded their visitor capacities or are under great amounts of visitor pressure, could *demarket* appealing species or activities through non-promotional techniques (e.g. non-promotion of the "Big Five"), or promotion of less popular species or less detrimental activities. Such shifts in marketing may in turn attract more specialist, environmentally conscious visitors (Di Minin et al., 2013; Duffus and Wipond, 1992; Lindsey et al., 2007; Okello, Manka, and D'Amour, 2008), for example, those with knowledge of the locations of the " Big Five", may still visit even if such species are not promoted. Intriguingly, a new, global "Big Five" not associated with consumptive hunting, is currently being generated with hopes of attracting WB tourists towards more threatened or endangered species (New Big 5, 2020). Contrarily, the potential candidate species are still highly iconic (e.g. Polar bear, orangutan, tiger, panda) and commonly used in flagship campaigns (Macdonald et al., 2015), therefore the new "Big Five" may still dismiss wider biodiversity.

The methodologies associated with Chapters 2 and 3 could also provide valuable insight into "must see" species which could be marketed by individual PAs, further reducing pressure on highly popular species. Additionally, by incorporating phenological data, "seasonal highlights" could be identified for each PA and marketed accordingly. Within sites, sightings boards could be generated to promote the whereabouts of popular and unpopular species alike. This approach could alter dispersion of visitors within PAs (Woods, 2000), reducing congestion, overcrowding and channelisation, therefore influencing tourist satisfaction (Ferreira and Harmse, 2014; Eagles, Mccool, and Haynes, 2002; Hausmann et al., 2017a). Likewise, the removal of such boards and reductions in sightings posts on social media could reduce tourist pressure on wildlife (e.g. speeding Arbieu et al., 2018), and threats from poaching.

5.4.2 Site Promotion

Promotional material (e.g. websites, media) can also be used to market site features which have been found to influence tourism visitation. For example, underutilised National Parks (NPs) in African countries with low HDI where crime and unrest are not commonplace (e.g. Kiang West NP in The Gambia) could promote a sense of security and solitude within the NP with assistance from social media and journalism. Educational material could also be promoted to portray the benefits of tourism in such deprived areas. Alternatively, underutilised NPs within African countries with high HDI (e.g. Agulhas NP in South Africa) could promote a sense of security associated with in-country travel.

The results from Chapters 2 and 3 also suggest that, to direct tourism towards underutilised sites, ease of access (e.g. nearby airfields) and distances to local amenities could be promoted. Increased signage could also potentially attract passers-by and aid in directing tourists towards sites (Steiner and Bristow, 2000). Sites which are significant distances from population centres could attract tourists by promoting "sense of place" experiences (e.g. bush skills or yoga retreats). Alternatively, sites which may be overutilised by tourists could promote difficulties with access (e.g. poorly maintained road infrastructure, Akama and Kieti, 2003). PA managers could additionally alter promotion of "place" and "price" features, such as increased entrance fees (e.g. Sissinghurst Castle Beeton and Benfield, 2002). Reduced visitor satisfaction could result if such restrictions are in place but not marketed in promotional material (Benfield, 2000).

Promotional techniques can be used to manage visitation by influencing the behavioural intentions, actions and responsibilities of individuals through education, information dissemination and understanding (Armstrong and Kern, 2011; Blackstock et al., 2008; Curtin, 2010). This study has highlighted the need to educate the public on aspects of ecology and conservation, which can be done with the use of promotional material. For example, the results of Chapter 3 suggest that American mink should be conserved for its tourism potential, when actually this would enhance its threat towards native British wildlife (Macdonald and Strachan, 1999; Macdonald and Tattersall, 2001; Macmillan and Phillip, 2008). Promotion can also be used to stress the importance of reducing the negative impacts of tourism development on wildlife and PAs (Duffus and Wipond, 1992), and therefore potentially divert tourists towards less frequented destinations and contribute to the responsible tourism goals of the Cape Town Declaration (Fabricius and Goodwin, 2002). Inappropriate behaviour, such as feeding animals and exiting vehicles during game drives, could be discouraged through signage, guidance and education within and outside of PAs (Beeton and Benfield, 2002). Ideally, these *demarketing* techniques could be developed to enhance public appreciation for nature and therefore the attitude of individuals and others through social currency (Blackstock et al., 2008; DEFRA, 2008; Middleton, 1996).

Chapter 6

General Discussion and Conclusion

6.1 What are the Traits of Species that Attract Tourism?

Chapters 2 and 3 investigated the characteristics which underline the appeal of the birds and terrestrial mammals of Africa and Great Britain (GB), respectively, to wildlife-based (WB) tourists using wildlife-based tourism (WBT) resources. A modelling framework was built to predict the popularity of species based upon their characteristics. These chapters aimed to provide insight into which species might currently be over-looked by tourism resources and hence might benefit from increased public awareness and education, to encourage tourists away from typical charismatic megafauna and to embrace wider biodiversity (Goodwin and Leader-Williams, 2000).

In Chapter 2, African birds with high body mass, large range size, a high degree of evolutionary distinctiveness, low migratory tendency, unusual appendages, high risk of extinction, high colour richness and high Bright Colour Index tended to be mentioned most often by the WBT resources. Birds associated with forest and open habitats were found to be the least popular. African mammals with high body mass, large range size, distinct patterning, no unusual appendages, and no unusual adornments tended to be the most popular. Solitary mammals were found to be mentioned in fewer WBT resources than group-living species. Mammals associated with open, mosaic and forest habitats tended to be the most popular.

In Chapter 3, carnivorous British birds with distinct patterning, and terrestrial mammals with large range sizes and unusual adornments, tended to be mentioned most often by WBT resources. Solitary mammals tended to be mentioned more often than group-living species. The poor ability of the modelling framework to accurately predict the popularity of British species suggests that additional WBT resources could be consulted (30 resources were consulted to determine African species popularity, whereas only eight resources were consulted to determine GB species popularity).

It is informative to contrast the species characteristics that appeal to WB tourists in relation to birds and mammals in Africa and GB. Many studies report that rare or range restricted species are the most appealing (Di Minin et al., 2013; Martin, 1997; Veríssimo et al., 2009). This study, however, found that range size was positively correlated with the popularity of all species except British birds. This could be an artefact of the methodology as wide-ranging species may be mentioned more often by the resources purely because they occur at a greater number of sites than rarer species.

Moreover, there were differences in the popularity of species characteristics between Africa and GB. Group-living mammals were found to be the most popular in Africa, whereas solitary mammals tended to be the most popular in GB. As mentioned in Chapter 3, these results may be attributed to the viewing ability of tourists. For example, group-living species may be more appealing to tourists that are generally restricted to within vehicles in African PAs (due to dangerous game, De Vos et al., 2016), but less appealing for tourists which can roam freely through British PAs. Additionally, group-living species in GB do not typically perform interesting behaviours at all times throughout the year (e.g. rutting season), whereas there is always the potential to watch, for example, an exhilarating hunt in Africa.

The popularity of mammal species also differed based on the presence of unusual adornments. The presence of unusual adornments tended to decrease the popularity of an African mammal species but increase the popularity of a British mammal species. This may reflect the number of species with unusual adornments across the two destinations, with over 100 African mammals but only seven British mammals possessing unusual adornments. Therefore, species with unusual adornments in Africa may be considered common, whereas species with unusual adornments in the UK may be quite rare and, therefore, more sought after.

Additionally, large-bodied African species were found to be the most popular but body mass had no effect on British species popularity. Based on the literature in Chapter 1, the expectation was that large-bodied species would be the most popular. The literature reviewed, however, principally considered large-bodied species not found in GB. The absence of influence of body mass on British species popularity may also reflect the lack of restrictions imposed on tourists within GB PAs. For example, as mentioned, tourists are generally not restricted to a vehicle, therefore ecological charisma, in relation to conspicuousness (Lorimer, 2007), may not be as important as when viewing wildlife in Africa.

Habitat association was also expected to influence species popularity. This was the case for African species, however, habitat associations had no effect on British species popularity. This may also reflect the ability of tourists in GB PAs to roam freely, and therefore not have restrictions on viewing ease.

Chapter 1 highlighted the issues regarding current understanding of what makes species appealing to the public. Studies aiming to quantify tourist preferences have typically restricted their scope to large-bodied, exotic mammals, and the methods for elucidating such information (e.g. stated and revealed preference techniques such as contingent valuation (CV) and choice experimentation (CE)) have been widely criticised (Blamey, Gordon, and Chapman, 1999; Farr, Stoeckl, and Alam Beg, 2014; Hill and Courtney, 2006; Lew, 2015; Ressurreição et al., 2011; Ressurreição et al., 2012; Richards and Friess, 2015;

Wood et al., 2013). There is great concern that such information diverts attention and resources away from wider biodiversity conservation (Goodwin and Leader-Williams, 2000; Kerley, Geach, and Vial, 2003).

The species traits which were found to appeal to tourists in this thesis were similar to those determined using alternative methods (e.g. Di Minin et al., 2013; Maciejewski and Kerley, 2014b; White et al., 1997), but also suggest that tourist preferences are not restricted to large-bodied charismatic megafauna. This suggests that, properly implemented, the novel approach of using WBT resources to define the appeal of species to tourists could be used as an alternative to current time consuming and costly methods, especially when being applied across numerous geographic locations. Additionally, this thesis provides evidence that changes in promotional material and public education could influence the tourism potential of species (not just birds and terrestrial mammals) and also create, maintain and restrict tourism demand, as discussed in depth in Chapter 5.

6.2 What are the Features of Protected Areas that Attract Tourism?

Chapters 2 and 3 investigated, with a second modelling framework, the extent to which the wildlife popularity (relating to a sites species pool and their popularity indices), along with additional biogeographical and socioeconomic variables, drive tourists to African National Parks (NPs) and GB protected areas (PAs), respectively. Further, the findings have provided insight into which destinations have high NBT potential but may currently be under- or over-utilised by tourists, relative to their traits, and therefore could benefit from specific management implications discussed in Chapter 5.

In Chapter 2, old African NPs with high habitat diversity and high wildlife popularity tended to be associated with the greatest visitor numbers. Additionally, NPs located close to cities and within countries associated with high levels of human development (according to the Human Development Index) tended to attract the most visitors.

In Chapter 3 British PAs with high habitat diversity were found to attract the most tourists. Additionally, PAs with large local catchment populations and within cooler environments were found to attract the most visitors. Mammal popularity was slightly positively correlated with visitor numbers and bird popularity was slightly negatively correlated with visitor numbers. The poor predicting power of the modelling framework developed in this chapter suggests that more visitor number data could be sourced and additional potential explanatory variables could be investigated.

It is informative to contrast the features of destinations which appeal to nature-based (NB) tourists in relation to NPs in Africa and PAs in GB. Both Chapters 2 and 3 highlight the importance of habitat diversity in determining the appeal of NPs and PAs to tourists, providing incentive to protect biodiverse areas for both conservation and tourism gain.

Moreover, there were differences in the drivers of NBT between Africa and GB. Visitor numbers to African NPs were negatively correlated with travel time to the nearest city of 50,000 people (i.e. more remote sites gain fewer visitors) and not influenced by the size of the local catchment population. Visitor numbers to British PAs were positively correlated with the size of the local catchment population (which was negatively correlated with travel time). These findings suggest that visitors to African NPs are predominantly coming from international origin (e.g. Di Minin et al., 2013), whereas visitors to British PAs are more likely to be domestic. As mentioned in Chapter 5, these findings have significant implications for management of tourist destinations.

Wildlife popularity was found to have a large, significant, positive effect on visitor numbers to African NPs. For GB PAs, however, mammal popularity had a small, non-significant, positive effect on visitor numbers and bird popularity had a small, non-significant positive effect on visitor numbers. This suggests that WBT plays a much stronger role in driving tourists to African NPs, whereas visitors to PAs within GB are less concerned about viewing wildlife. The results provide an economic case for the conservation of African species, further supporting the development of WBT operations, particularly in areas currently underutilised by the NBT industry. WBT can therefore act as a source of revenue for biodiversity conservation within and outside of African NPs, whilst further providing sustainable economic opportunities for local people, potentially increasing their support for tourism and conservation (Abukari and Mwalyosi, 2018; Child, 1996; Goodwin and Leader-Williams, 2000; Grünewald, Schleuning, and Böhning-Gaese, 2016; Lindsey et al., 2007; Tapper, 2006; Walpole and Thouless, 2005; Willemen et al., 2015).

Age of NP was found to influence tourism visitation to African NPs but not GB PAs. African NPs typically encompass tourist facilities and amenities, including accommodation and road networks. Older NPs may have had more time to develop these features which appeal to tourists, typically international tourists (Balmford et al., 2015; Hanink and White, 1999; Neuvonen et al., 2010). GB PAs, however, do not generally encompass these sorts of features associated with international tourism, therefore potentially reducing the importance of age on tourism visitation in GB (Bourdieu, 1984; Greenway, 1995).

Chapter 1 highlighted the issues regarding current understanding of what drives tourists to destinations. Methods aiming to elucidate such drivers have involved guesswork, and stated or revealed preference techniques which have been widely criticised as mentioned above. Modelling visitor numbers can provide valuable insight into what drives people to participate in NBT within PAs and recreational areas (RAs), and therefore how site managers can sustainably manage and market such destinations for both tourism and conservation gain (Eagles, 2014; Phillips, 1998), as discussed in Chapter 5.

The features of sites which were found to appeal to tourists in this thesis were similar to those determined using alternative methods (e.g. Akama and Kieti, 2003; Hausmann et al., 2017b). This suggests that visitor number data could be used as an alternative to current time-consuming and costly methods, especially when being applied across numerous geographic locations. The data could also provide insight into how tourism changes over varying temporal scales, and could also be used to predict how tourism visitation could change in the future with regards to the Covid-19 pandemic. This study also provided evidence that visitor number data is variable in its consistency and patchy in its occurrence, this calls for more consistent visitor monitoring techniques.

6.3 Can Modified Infrared Cameras be Used to Monitor Tourism Visitation?

Chapter 4 reported a pilot investigation into the potential for modified infrared trail cameras to be used to count visitors to GB PAs and RAs. Visitor numbers to a subset of GB PAs and RAs, as determined by the cameras, were compared to visitor data recorded by other means. The findings suggest that wildlife trail cameras could be used easily to monitor footfall within PAs and RAs, and they provide a cost-effective means of providing comparable visitor data concurrently across large numbers of sites. Once images are calibrated for visitor trigger rates, cameras can also provide very high temporal resolution on daily visitor patterns. Such data could be informative for site managers with regards to managing tourism flow especially at destinations which currently do not record visitors.

6.4 Recommendations for Future Study

6.4.1 Species Popularity

Additional traits not considered by this study but which may influence the tourism potential of birds and terrestrial mammal species, such as endemicity, threat to humans and familiarity (e.g. Macdonald et al., 2015), have been discussed at length in Chapters 2 and 3 and could be considered in further analyses. Species collections in captivity could be used to estimate a proxy for the familiarity of a species to tourists. For example, a species held in many zoo collections may be more familiar to tourists than those not held in captivity, and therefore may be mentioned more frequently by the WBT resources. This would assist in evaluating the extent to which captive wildlife influences the appeal of non-captive wildlife, and therefore how zoo collections could be managed to educate the public. Likewise, analysing aspects of media, such as the portrayal of species in film and documentaries, or the representation of species on social media could help refine the understanding of what drives the popularity of species in WBT resources (Albert, Luque, and Courchamp, 2018; Beeton, 2006; Bulbeck, 2005; Glickman, 1995; Wood et al., 2013).

6.4.2 The Drivers of Visitor Numbers

This study further suggest that additional factors could be considered to identify hotspots of NBT appeal as discussed in depth in Chapters 2 and 3. Future studies could evaluate the effect of aesthetic landscapes, tourist facilities within sites, educational and tour opportunities, entrance fees, carbon/ecological footprint, and nearby non-NBT attractions on tourism visitation (Akama and Kieti, 2003; Grünewald, Schleuning, and Böhning-Gaese, 2016; Hausmann et al., 2017a; Hunter and Shaw, 2007; Neuvonen et al., 2010; Okello, Manka, and D'Amour, 2008; SANParks, 2006). More specifically for NPs in developing countries which receive many international tourists, considering accommodation prices and cell-phone coverage may prove beneficial (Akama and Kieti, 2003; Hausmann et al., 2017b). More specifically for PAs in developed countries which may rely on domestic tourism for visitation, research could consider alternative local catchment indices (e.g. how many people live within a 1-hour drive), public transport and car parking availability.

Future studies aiming to evaluate the drivers of tourism could also consider the micro-scale factors which are thought to influence tourists decisions, though they may be difficult to quantify. For example, factors which constitute to a "sense of place" (e.g. overcrowding, symbolic depictions of destinations) and socio-economic demographics (e.g. age and income of tourists) (Barendse et al., 2016; Curtin and Wilkes, 2005; Curtin, 2013a; Diamantis, 1999; Di Minin et al., 2013; Hausmann et al., 2016; Hausmann et al., 2017b; Lemelin, 2006; Millenium Ecosystem Assessment, 2005;Ressurreição et al., 2012; Tuan, 1997; Xu and Fox, 2014).

Visitor spending within and outside of site boundaries could also provide insight into the appeal of sites to tourists and the benefits and economic significance of NBT (Balmford et al., 2015; Neuvonen et al., 2010). Moreover, the effect of visitor satisfaction on visitor numbers could be considered (Alegre and Garau, 2010; Neal and Gursoy, 2008). Satisfied tourists are more likely to engage in return visits, recommend the site to the public, and therefore enhance the reputation of the site (Akama and Kieti, 2003; Goodwin and Leader-Williams, 2000; Gössling, 1999; Okello, Manka, and D'Amour, 2008). Therefore understanding what influences tourist satisfaction could provide useful implications for site management (Maciejewski and Kerley, 2014b; Okello, Manka, and D'Amour, 2008).

6.4.3 Future Changes in Nature-Based Tourism Potential

Climate change is predicted to substantially influence the role of NBT within PAs by affecting, for example, where recreational activities can occur (e.g. mountaineering, Nyaupane and Chhetri, 2009), where and when species and habitats can be found (e.g. Bagchi et al., 2013; Chen et al., 2011; Parmesan and Yohe, 2003; Root et al., 2003; Saarinen et al., 2012; Thomas et al., 2004), and changes in species tourism-appeal relating to range size, extinction risk and abundance (Angulo and Courchamp, 2009; Arponen et al., 2005; Booth et al., 2011; Di Minin et al., 2013; Reynolds and Braithwaite, 2001).

Predicted species distributions under future economic and climatic change scenarios can be used to identify shifts in species assemblages, and therefore the location of WBT and

NBT hotspots within and outside of the PA network (Hannah et al., 2007). The destinations which can be predicted to gain popular species could attract tourists from far and wide, further benefiting local economies and potentially enhancing the support of the public towards conservation (Akama and Kieti, 2003; Liu et al., 2013; Tapper, 2006; Walpole and Thouless, 2005). The locality of future WBT hotspots, however, is also dependent on geographical barriers to species dispersal in response to climatic variables (Hoegh-Guldberg et al., 2008), the availability and composition of suitable habitat (Bagchi et al., 2013; Richardson and Loomis, 2004), and the persistence of species interactions associated with the presence or absence of other species (Loss, Terwilliger, and Peterson, 2011). Based upon future species distribution scenarios, current PAs which are expected to retain their WBT potential could benefit from continued investment into species conservation as well as investment into additional features which influence tourism visitation (e.g. accessibility). Areas which are predicted to have high future WBT potential but lie outside of the current PA network could be protected from development. Further, increased connectivity between the PA network may facilitate the shifts in species distributions under future climatic and economic scenarios. Increased connectivity and the establishment of new PAs, however, may conflict against development proposals in areas with high land use values (Jackson and Gaston, 2008).

The synergism of climatic change and other anthropogenic stressors on species persistence, such as agricultural intensification (Newton, 2004), could increase species fragmentation and conflict with humans, therefore threatening their existence (Fahrig, 2003; Hewitt et al., 2011; Lasky and Keitt, 2013). Predicting the availability of species in the future based on these imminent threats, educating managers and local communities about these threats (Saarinen et al., 2012), and investing in adaptation strategies (e.g. Mawdsley, O'Malley, and Ojima, 2009), is important for the future survival of global wildlife and nature-based tourism.

6.5 Conclusion

This thesis has identified the characteristics of African and British birds and terrestrial mammal species which determine their appeal to WB tourists as well as species which are currently overlooked by tourism, relative to their characteristics, with use of widely available WBT resources. This thesis has also identified drivers of NBT across Africa and GB using visitor number data. Modified infrared cameras were trialled as a cost-efficient means of recording visitor numbers within British PAs and RAs. The results provided valuable insight into implications of PA management strategies, especially with reference to the *demarketing* approach (Kotler and Levy, 1971) which aims to generate an equilibrium between sustainable conservation management, visitor pressure and economic revenue (Armstrong and Kern, 2011; Beeton and Benfield, 2002). This research, however, was limited to examining the relationship between certain variables. It is suggested that other socially constructed factors, such as familiarity and "sense of place", could be explored in the future. Likewise, the modelling frameworks used to predict visitor numbers could be used to forecast future visitor distributions under predictions of economic, climatic, and environmental change scenarios.

Appendix A

A.1 Supplementary Material for Chapters 2 and 3

A.1.1 Habitat Classifications for Bird Species

TABLE A.1: BirdLife International habitat types which were grouped by PhD student, Kirkland (2020).

Habitat type	**Category level**
Grassland Savannah	Open vegetation
Desert Rocky areas	Bare
Forest	Forest
Shrubland	Shrubland
Artificial / Aquatic & Marine Artificial / Terrestrial	Artificial
Marine Coastal / Supratidal Marine Intertidal Marine Neritic Marine Oceanic Wetlands (inland)	Aquatic
Caves (non-aquatic) Other	Other

A.1.2 Habitat Classifications for Terrestrial Mammal Species

TABLE A.2: Global Mammal Assessment Programme habitat types which were grouped by PhD student, Kirkland (2020).

Habitat type	**Category level**
Cultivated and Managed areas	Artificial
Post-flooding or irrigated croplands (or aquatic)	
Post-flooding or irrigated shrub or tree crops	
Post-flooding or irrigated herbaceous crops	
Rainfed croplands	
Rainfed herbaceous crops	
Rainfed shrub or tree crops (cashcrops, vineyards, olive tree, orchards)	
Artificial surfaces and associated areas (Urban areas >50%)	
Mosaic cropland (50-70%) / vegetation (grassland/shrubland/forest) (20-50%)	Mosaic
Mosaic cropland (50-70%) / grassland or shrubland (20-50%)	
Mosaic cropland (50-70%) / forest (20-50%)	
Mosaic vegetation (grassland/shrubland/forest) (50-70%) / cropland (20-50%)	
Mosaic grassland or shrubland (50-70%) / cropland (20-50%)	
Mosaic forest (50-70%) / cropland (20-50%)	
Mosaic forest or shrubland (50-70%) and grassland (20-50%)	
Mosaic grassland (50-70%) and forest or shrubland (20-50%)	
Closed to open (>15%) broadleaved evergreen or semi-deciduous forest (>5m)	Forest
Closed (>40%) broadleaved evergreen and/or semi-deciduous forest	
Open (15-40%) broadleaved semi-deciduous and/or evergreen forest with emergents	
Closed (>40%) broadleaved deciduous forest (>5m)	
Open (15-40%) broadleaved deciduous forest/woodland (>5m)	
Closed (>40%) needle-leaved evergreen forest (>5m)	

Closed (>40%) needle-leaved deciduous forest (>5m)	
Open (15-40%) needle-leaved deciduous or evergreen forest (>5m)	
Open (15-40%) needle-leaved deciduous forest (>5m)	
Open (15-40%) needle-leaved evergreen forest (>5m)	
Closed to open (>15%) mixed broadleaved and needleaved forest	
Closed (>40%) mixed broadleaved and needleaved forest	
Open (15-40%) mixed broadleaved and needleaved forest	
Closed to open (>15%) (broadleaved or needle-leaved, evergreen or deciduous) shrubland (<5m)	
Closed to open (>15%) broadleaved or needle-leaved evergreen shrubland (<5m)	
Closed to open (>15%) broadleaved evergreen shrubland (<5m)	
Closed to open (>15%) needle-leaved evergreen shrubland (<5m)	Shrubland
Closed to open (>15%) broadleaved deciduous shrubland (<5m)	
Closed (>40%) broadleaved deciduous shrubland (<5m)	
Open (15-40%) broadleaved deciduous shrubland (<5m)	
Closed to open (>15%) herbaceous vgt (grassland, savannas or Lichens/Mosses)	
Closed (>40%) grassland	
Closed (>40%) grassland with sparse (<15%) trees or shrubs	
Open (15-40%) grassland	
Open (15-40%) grassland with sparse (<15%) trees or shrubs	Open vegetation
Lichens or Mosses	
Sparse (<15%) vegetation	
Sparse (<15%) grassland	
Sparse (<15%) shrubland	
Sparse (<15%) trees	
Bare areas	

Bare

Consolidated bare areas (hardpands, gravels, bare rock, stones, boulders) Non-consolidated bare areas (sandy desert) Salt hardpands	
Permanent Snow and Ice	Snow ice

A.1.3 Bright Colour Index Examples

Three examples of species classified with high (Fig. A.1), medium (Fig. A.2), and low (Fig. A.3) Bright Colour Indices are provided below.

FIGURE A.1: The black-bellied starling, *Lamprotornis corruscus*, which has a high BCI value (0.0833) with iridescent black, blue, blue-green, green and blue-violet colouration. Image courtesy of Tarboton, W. [online] available at: https://www.warwicktarboton.co.za/

FIGURE A.2: Reichenbach's sunbird, *Anabathmis reichenbachii*, with a medium BCI value (0.0417) with iridescent violet and blue-violet. Image courtesy of HBW Alive (del Hoyo et al., 2018).

FIGURE A.3: The African plain martin, *Riparia paludicola*, with a low BCI value (0) with no iridescent or bright colouration. Image courtesy of HBW Alive (del Hoyo et al., 2018).

A.1.4 IUCN Governance of Protected Areas Categories

TABLE A.3: The 11 sub-types of PA governance grouped into four broad categories by the IUCN Governance of Protected Area guidelines (Borrini-Feyerabend et al., 2013).

Governance Sub-type	IUCN Governance Type Category
Federal or national ministry or agency in charge	A
Government-delegated management (e.g., to an NGO)	A
Sub-national ministry or agency in charge (e.g. at regional, provincial, municipal level)	A
Collaborative governance (through various ways in which diverse actors and institutions work together)	B
Transboundary governance (formal arrangements between one or more sovereign States or Territories)	B
Joint governance (pluralist board or other multi-party governing body)	B
Conserved areas established and run by: for-profit organisations (e.g., corporate landowners)	C
Conserved areas established and run by: individual landowners	C
Conserved areas established and run by: non-profit organisations (e.g., NGOs, universities)	C
Indigenous peoples' conserved territories and areas – established and run by indigenous peoples	D
Community conserved areas and territories - established and run by local communities	D

A.2 GitHub Online Appendix

The following information can be found in the online GitHub appendix at https://github.com/hmappleby/Thesis_supplements;

- Word documents describing the physical trait data extracted for birds and terrestrial mammal species.
- Data analysed by the African bird GLMM, African mammal GLM, African NP GLM, GB bird GLM, GB mammal GLM, GB PA GLM.
- Visitor number data sourced for African NPs and GB PAs. Data are displayed in the same manner as Balmford et al. (2015), where (*) indicates data provided in confidence.

A.3 Supplementary Results for Chapter 2

TABLE A.4: Effect size and significance of individual variables in explaining the observed variance in the popularity of African bird species across the WBT resources, based on the global GLMM. Trophic level estimates were relative to the effect of Carnivores. The estimate for the time partitioning was relative to the estimate of diurnal species. Habitat association estimates were relative to the effect of species occupying aquatic habitats. The estimate for non-colonial species was relative to the effect of colonial species. The estimates for the presence of unusual appendages, unusual adornments and distinct patterning were relative to the effect of the absence of these traits. P values significant at 5% levels are shown in bold.

Variable	**Estimate**	**SE**	**z value**	**Pr(> | z |)**
Intercept	1.080914	0.086131	12.549590	<**0.000001**
log_{10} body mass	0.244174	0.027080	9.016839	<**0.000001**
log_{10} African range size	0.149087	0.021821	6.832329	<**0.000001**
Migratory tendency	-0.116979	0.019082	-6.130338	<**0.000001**
Evolutionary distinctiveness	0.087170	0.014630	5.958391	<**0.000001**
Unusual appendages: present	0.088341	0.016125	5.478353	<**0.000001**
Extinction risk	-0.067318	0.016832	-3.999493	**0.000063**
Habitat: Forest	-0.175112	0.057220	-3.060303	**0.002211**
Bright Colour Index	0.043292	0.016436	2.633991	**0.008439**
Habitat: Open vegetation	-0.113877	0.055478	-2.052640	**0.040108**
Habitat: Artificial	-0.132376	0.073840	-1.792745	0.073014
Coloniality: Not colonial	-0.073339	0.048749	-1.504425	0.132472
Habitat: Bare habitat	0.114862	0.078274	1.467440	0.142256
Habitat: Shrubland	-0.096538	0.066105	-1.460382	0.144185
Colour richness	0.016635	0.017564	0.947158	0.343558
Distinct patterning: present	0.013476	0.016924	0.796233	0.425897
Unusual adornments: present	0.006240	0.015040	0.414856	0.678247
Trophic level: Herbivore	-0.018112	0.046661	-0.388159	0.697899
Time partitioning: Nocturnal	-0.028377	0.097754	-0.290287	0.771597
Trophic level: Omnivore	-0.012627	0.048556	-0.260056	0.794820
Habitat: Other	0.030709	0.305026	0.100678	0.919806

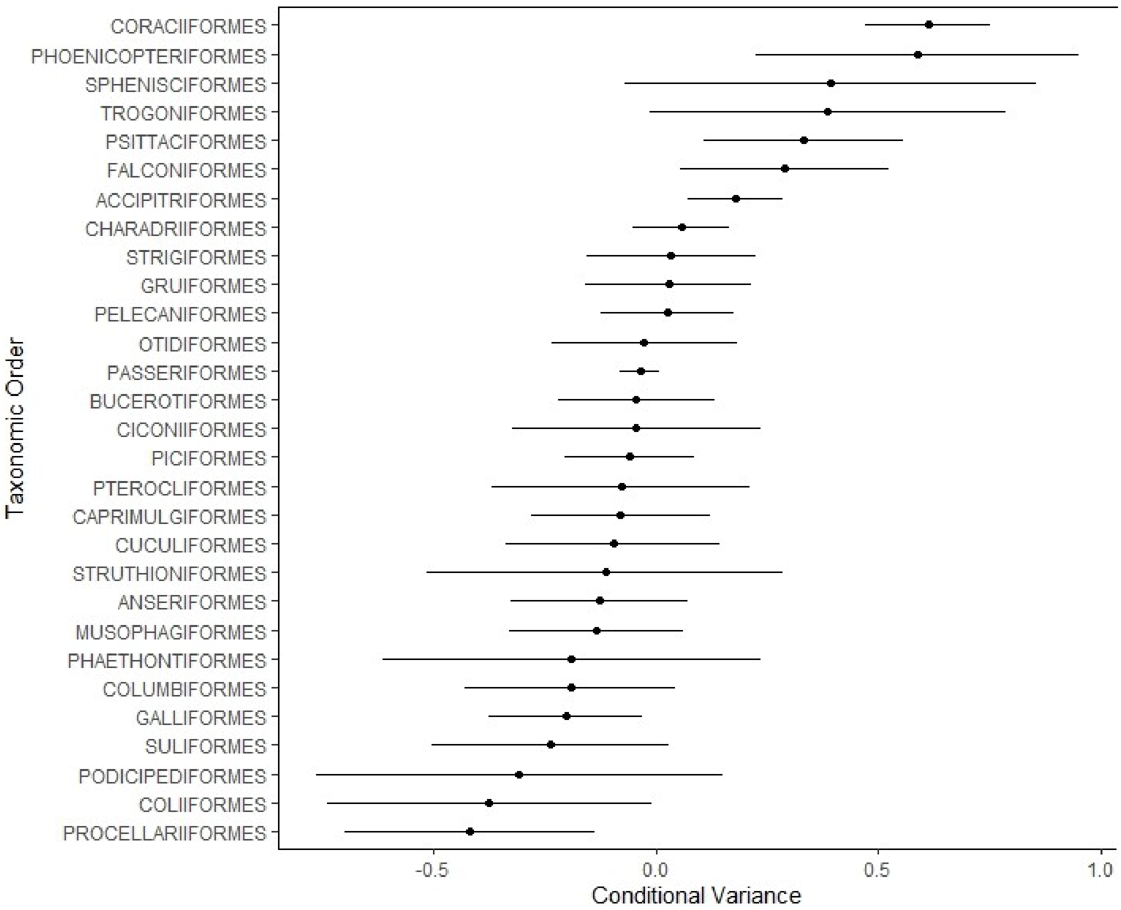

FIGURE A.4: The conditional variances of the taxonomic orders of African bird species which were included in the GLMM as a random effect.

TABLE A.5: The model-averaged GLMM coefficients used to predict the popularity of African bird species across the WBT resources. Habitat association estimates were relative to the effect of species occupying aquatic habitats. The estimate for the presence of unusual appendages was relative to the effect of absence of unusual appendages. P values significant at 5% levels are shown in bold.

Variable	**Estimate**	**SE**	**z value**	**Pr(>|z|)**
Intercept	1.022836	0.077703	13.154270	<**0.000001**
log_{10} body mass	0.243676	0.026007	9.363156	<**0.000001**
log_{10} African range size	0.148584	0.021650	6.858102	<**0.000001**
Unusual appendages: present	0.093334	0.015489	6.021749	<**0.000001**
Evolutionary distinctiveness	0.083551	0.014428	5.786902	<**0.000001**
Migratory tendency	-0.114329	0.018764	6.088701	<**0.000001**
Extinction risk	-0.069206	0.016766	4.124897	**0.000037**
Habitat: Forest	-0.185550	0.056353	3.290331	**0.001001**
Habitat: Open vegetation	-0.120329	0.054679	2.199092	**0.027871**
Bright Colour Index	0.039804	0.020592	1.932278	0.053325
Habitat: Artificial	-0.136551	0.073307	1.861450	0.062681
Habitat: Shrubland	-0.107282	0.065326	1.641110	0.100775
Habitat: Bare	0.114271	0.077875	1.466340	0.142556
Colour richness	0.001544	0.007328	0.210693	0.833127
Habitat: Other	-0.004256	0.302239	0.014070	0.988774

TABLE A.6: Effect size and significance of individual variables in explaining the observed variance in the popularity of African mammal species across the WBT resources, based on the global GLM. Trophic level estimates were relative to the effect of Carnivores. Time partitioning estimates were relative to the effect of cathemeral species. Habitat association estimates were relative to the effect of species occupying bare habitats. The estimate for solitary species was relative to the effect of group-living species. The estimates for the presence of unusual appendages, unusual adornments and distinct patterning were relative to the effect of the absence of these traits. P values significant at 5% levels are shown in bold.

Variable	**Estimate**	**SE**	**z value**	**Pr(> | z |)**
Intercept	1.717675	0.278892	6.158935	<**0.000001**
log_{10} body mass	0.472051	0.067702	6.972474	<**0.000001**
log_{10} African range size	0.417262	0.067113	6.217312	<**0.000001**
Unusual appendages: present	-0.257199	0.099460	-2.585959	**0.009711**
Sociality: Solitary	-0.289252	0.112205	-2.577882	**0.009941**
Habitat: Open vegetation	0.439593	0.205728	2.136765	**0.032617**
Distinct patterning: present	0.197706	0.103471	1.910728	0.056039
Habitat: Mosaic	0.273865	0.182955	1.496893	0.134421
Unusual adornments: present	-0.173889	0.118411	-1.468513	0.141965
Habitat: Forest	0.193261	0.172795	1.118443	0.263378
Colour richness	-0.035318	0.043794	-0.806449	0.419984
Time partitioning: Nocturnal	-0.122823	0.178834	-0.686800	0.492209
Trophic level: Omnivore	-0.091148	0.136273	-0.668863	0.503583
Extinction risk	-0.040186	0.060819	-0.660755	0.508770
Trophic level: Herbivore	-0.065838	0.142286	-0.462715	0.643569
Evolutionary distinctiveness	0.015072	0.043573	0.345902	0.729416
Time partitioning: Diurnal	0.051731	0.167910	0.308087	0.758016
Time partitioning: Crepuscular	0.031984	0.255657	0.125106	0.900439

TABLE A.7: The model-averaged GLM coefficients used to predict the popularity of African mammal species across the WBT resources. Habitat association estimates were relative to the effect of species occupying bare habitats. The estimate for solitary species was relative to the effect of group-living species. The estimates for the presence of unusual appendages, unusual adornments and distinct patterning were relative to the effect of the absence of these traits. P values significant at 5% levels are shown in bold.

Variable	**Estimate**	**SE**	**z value**	**Pr(>|z|)**
Intercept	1.878178	0.158845	11.788408	<**0.000001**
log_{10} body mass	0.505166	0.062429	8.060773	<**0.000001**
log_{10} African range size	0.372121	0.049729	7.447229	<**0.000001**
Sociality: Solitary	-0.346336	0.094275	3.656291	**0.000256**
Unusual appendages: present	-0.202085	0.117232	1.718736	0.085662
Unusual adornments: present	-0.177892	0.128697	1.378771	0.167965
Distinct patterning: present	0.110391	0.124813	0.882970	0.377253
Habitat: Open vegetation	0.125550	0.236454	0.530499	0.595766
Habitat: Mosaic	0.076244	0.158254	0.481016	0.630505
Habitat: Forest	0.052789	0.123906	0.425059	0.670794

TABLE A.8: Effect size and significance of individual variables in explaining the observed variance in the visitor numbers to African NPs, based on the global GLM. P values significant at 5% levels are shown in bold.

Variable	**Estimate**	**SE**	**t value**	**Pr(>|t|)**
Intercept	3.128139	0.468619	6.675221	<**0.000001**
HDI	0.672901	0.098785	6.811774	<**0.000001**
Wildlife popularity	0.438526	0.130581	3.358274	**0.001416**
Habitat diversity	0.301216	0.096863	3.109712	**0.002943**
Habitat: Grassland	0.822324	0.483567	1.700538	0.094578
Age	0.143491	0.092541	1.550562	0.126640
Habitat: Water bodies	0.788386	0.832173	0.947382	0.347514
log_{10} area	-0.108066	0.129928	-0.831735	0.409091
Habitat: Mosaic	0.409884	0.505693	0.810539	0.421062
Accessibility	-0.093516	0.118526	-0.788993	0.433444
Local catchment population	0.044062	0.094848	0.464555	0.644051
Habitat: Shrubland	0.176462	0.571928	0.308540	0.758817
Habitat: Forest	0.101408	0.497029	0.204029	0.839071

TABLE A.9: The model-averaged GLM coefficients used to predict the visitation numbers to African NPs. P values significant at 5% levels are shown in bold.

Variable	**Estimate**	**SE**	**z value**	**Pr(> |z|)**
Intercept	3.493941	0.103177	33.271904	<**0.000001**
HDI	0.725037	0.096377	7.393983	<**0.000001**
Wildlife popularity	0.466258	0.121213	3.774176	**0.000161**
Habitat diversity	0.302442	0.090159	3.291556	**0.000996**
Age	0.113801	0.125191	0.904572	0.365692
Accessibility	-0.106995	0.129195	0.824317	0.409760

A.4 Supplementary Results for Chapter 3

TABLE A.10: Effect size and significance of individual variables in explaining the observed variance in the popularity of GB bird species across the WBT resources, based on the global GLM. Trophic level estimates were relative to the effect of carnivores. The estimate for the time partitioning was relative to the estimate of diurnal species. Habitat association estimates were relative to the effect of species occupying aquatic habitats. The estimate for non-colonial species was relative to the effect of colonial species. The estimates for the presence of unusual appendages, unusual adornments and distinct patterning were relative to the effect of the absence of these traits. P values significant at 5% levels are shown in bold.

Variable	**Estimate**	**SE**	**z value**	**Pr(>|z|)**
Intercept	1.690087	0.102897	16.427927	$<$**0.000001**
Distinct patterning: present	0.218129	0.100690	2.166335	**0.030286**
Trophic level: Herbivore	-0.136942	0.082621	-1.657475	0.097424
log_{10} GB range size	0.038521	0.029185	1.319878	0.186876
Habitat: Other	-0.643583	0.590908	-1.089143	0.276091
Unusual adornments: present	0.078997	0.106280	0.743294	0.457304
Trophic level: Omnivore	-0.051739	0.073218	-0.706649	0.479784
Time partitioning: Nocturnal	0.095573	0.137035	0.697431	0.485533
BCC status	-0.019449	0.028095	-0.692260	0.488774
Global extinction risk	0.019345	0.029471	0.656422	0.511553
Habitat: Forest	-0.046226	0.080324	-0.575500	0.564953
Habitat: Artificial	-0.054874	0.105950	-0.517927	0.604509
Colour richness	-0.017088	0.036140	-0.472828	0.636336
Bright Colour Index	-0.012704	0.030180	-0.420931	0.673805
Migratory strategy	0.012978	0.031393	0.413416	0.679302
log_{10} body mass	-0.013322	0.034040	-0.391369	0.695525
Colonial: Not colonial	-0.017831	0.062838	-0.283754	0.776599
Habitat: Shrubland	-0.033706	0.120091	-0.280672	0.778962
Unusual appendages: present	0.020944	0.096447	0.217154	0.828089
Evolutionary distinctiveness	0.002111	0.028139	0.075015	0.940203
Habitat: Bare	0.006530	0.142326	0.045880	0.963406
Habitat: Open vegetation	0.002055	0.088603	0.023199	0.981492

TABLE A.11: The model-averaged GLM coefficients used to predict the popularity of GB bird species across the WBT resources.Trophic level estimates were relative to the effect of carnivores. The estimate for the presence of distinct patterning was relative to the effect of the absence of this trait.

Variable	**Estimate**	**SE**	**z value**	**Pr(>|z|)**
Intercept	1.721719	0.106331	16.145346	$<$**0.000001**
Distinct patterning: present	0.151526	0.113318	1.333617	0.182329
Trophic level: Herbivore	-0.087097	0.091636	0.948723	0.342762
Trophic level: Omnivore	-0.038209	0.062851	0.605612	0.544773

TABLE A.12: Effect size and significance of individual variables in explaining the observed variance in the popularity of GB mammal species across the WBT resources, based on the global GLM. Trophic level estimates were relative to the effect of carnivores. Time partitioning estimates were relative to the effect of cathemeral species. Habitat association estimates were relative to the effect of species occupying artificial habitats. The estimate for solitary species was relative to the effect of group-living species. The estimates for the presence of unusual appendages, unusual adornments and distinct patterning were relative to the effect of the absence of these traits. P values significant at 5% levels are shown in bold.

Variable	**Estimate**	**SE**	**z value**	**Pr(>|z|)**
Intercept	2.840020	0.789504	3.597223	**0.000322**
Colour richness	0.324574	0.129299	2.510259	**0.012064**
Distinct patterning: present	-0.312095	0.282515	-1.104702	0.269289
Unusual appendages: present	-0.348204	0.232114	-1.500144	0.133577
Unusual adornments: present	-0.618486	0.480498	-1.287177	0.198033
Extinction risk	-0.022457	0.122849	-0.182804	0.854952
Sociality: solitary	0.113157	0.256143	0.441774	0.658653
Time partitioning: Crepuscular	0.367689	0.456325	0.805762	0.420380
Time partitioning: Diurnal	0.574618	0.425924	1.349110	0.177302
Time partitioning: Nocturnal	-0.472482	0.282395	-1.673124	0.094303
log_{10} body mass	0.241997	0.196944	1.228758	0.219162
log_{10} GB range size	0.185853	0.128898	1.441862	0.149341
Habitat: Bare	-0.339053	0.673432	-0.503471	0.614633
Habitat: Forest	-0.356558	0.423930	-0.841078	0.400304
Habitat: Mosaic	-0.543733	0.568397	-0.956606	0.338766
Habitat: Open vegetation	-0.656909	0.599688	-1.095419	0.273333
Trophic level: Herbivore	-0.715738	0.389816	-1.836094	0.066344
Trophic level: Omnivore	-0.100241	0.242887	-0.412705	0.679823
Evolutionary distinctiveness	0.076438	0.097956	0.780329	0.435197

TABLE A.13: The model-averaged GLM coefficients used to predict the popularity of GB mammal species across the WBT resources.The estimate for solitary species was relative to the effect of group-living species. The estimates for the presence of unusual appendages was relative to the effect of the absence of this trait. P values significant at 5% levels are shown in bold.

Variable	**Estimate**	**SE**	**z value**	**Pr(>|z|)**
Intercept	1.560982	0.170892	8.972284	<**0.000001**
Social: Solitary	0.118391	0.181157	0.644268	0.519402
log_{10} GB range size	0.195411	0.107033	1.787751	0.073816
Unusual adornments: present	0.231913	0.220160	1.036260	0.300081

TABLE A.14: Effect size and significance of individual variables in explaining the observed variance visitation rates of GB PAs, based on the global GLM.Habitat estimates were relative to the effect of urban areas. Governance estimates were relative to the effect of category A governance (national or federal). P values significant at 5% levels are shown in bold.

Variable	**Estimate**	**SE**	**t value**	**Pr(> |t|)**
Intercept	4.950714	0.861756	5.744911	<**0.000001**
Habitat diversity	0.082571	0.037162	2.221930	**0.027426**
Mammal popularity	0.002380	0.001315	1.809478	0.071901
Temperature	-0.109928	0.060921	-1.804426	0.072692
Bird popularity	-0.000790	0.000477	-1.656749	0.099162
log_{10} local catchment population	0.147548	0.089573	1.647245	0.101102
Habitat: Mosaic	-0.758493	0.569857	-1.331025	0.184719
Habitat: Grassland	-0.710107	0.585934	-1.211923	0.226993
Habitat: Water bodies	-0.537570	0.587925	-0.914350	0.361650
Governance: C	0.691164	0.800776	0.863117	0.389122
Governance: D	-0.097481	0.143977	-0.677058	0.499164
Habitat: Cropland	-0.459792	0.688256	-0.668054	0.504881
Habitat: Sparse vegetation or bare	-0.603821	1.002659	-0.602219	0.547721
Age	0.001736	0.003710	0.468001	0.640301
Habitat: Forest	-0.301637	0.801522	-0.376330	0.707077
log_{10} area	0.040771	0.166173	0.245354	0.806438

TABLE A.15: The model-averaged GLM coefficients used to predict the visitation rates of GB PAs. P values significant at 5% levels are shown in bold.

Variable	**Estimate**	**SE**	**z value**	**Pr(>|z|)**
Intercept	3.843712	0.465417	8.230605	<**0.000001**
Habitat diversity	0.098111	0.025586	3.812664	**0.000138**
Mammal popularity	0.001496	0.001390	1.072702	0.283405
Temperature	-0.045261	0.062557	0.722201	0.470171
log_{10} local catchment population	0.069985	0.097857	0.713807	0.475347
Bird popularity	-0.000363	0.000516	0.701745	0.482838

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